The AMSAT Journal

Incorporating the AMSAT Newsletter

Volume 13 No. 2 May 1990

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Managing Editor: **Robert M. Myers, W1XT**

CQ EARTH, This is MIR Calling

By Valery Kondratko, UV3DQE, and Joe Kasser, G3ZCZ[1]

Background

The last manned space flight that excited Amateur Radio began routinely on December 21 1987, when Commander Vladimir Titov and spacecraft engineer Musa Manarov[2] replaced Yuri Romanenko, Aleksander Aleksandrov, and Anatoly Levchenko aboard the MIR orbiting complex, for a one-year tour of duty. For the first two weeks of the flight, the cosmonauts got acclimatized to the space station, the equipment, and to coordination with mission control. A great amount of stellar observations, photographing of the Earth's surface, medical checkups and experiments, and maintenance of the spacecraft systems occupied all the crew's attention. After that things fell into a routine, for unlike in ships at sea, there is no weather in space (apart from solar flares and meteor storms) to cause distractions and so monotony and boredom tended to set in. This happens to all long duration crews, so they try to find something interesting to counteract the monotony and boredom, and avoid negative psychological effects.

Initial Steps in Ham Radio

In a conversation with ground control on the eve of the launch of the automatic supply vessel "Progress-35" in March 1988, Musa Manarov asked for copies of "Radio" magazine to be sent up. When the Psychological Support Group, amongst whose duties it was to deal with requests by crew members, received this request, they asked the editorial offices of "Radio" to provide several issues that Musa had not read. At the editorial offices, they were delighted by his interest and enclosed a letter along with the magazines. The letter asked among other questions,

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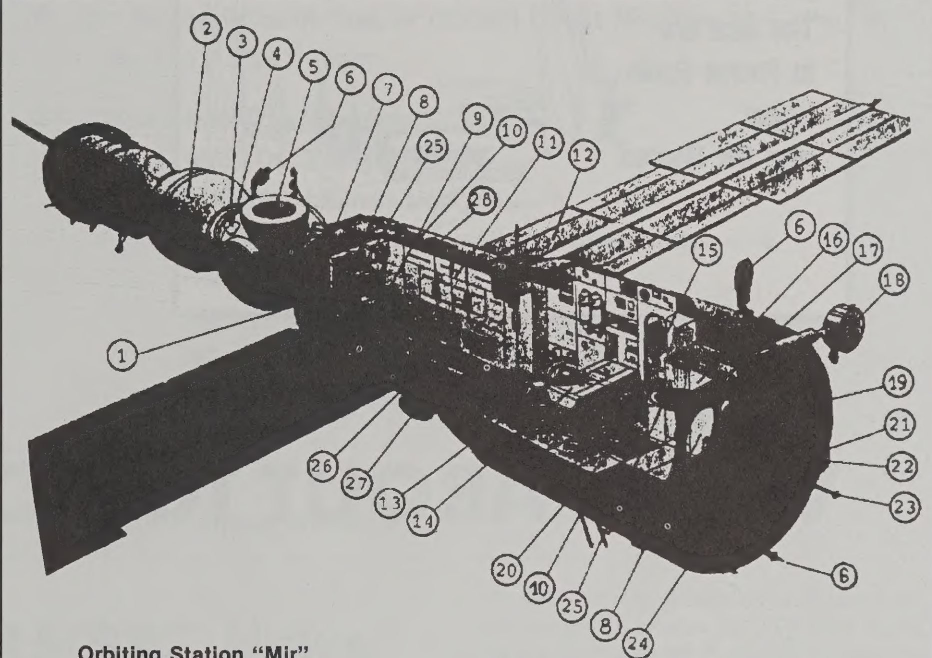

Orbiting Station "Mir"

1. Basic module
2. "Soyuz T" vessel
3. Transfer compartment
4. Manipulator socket
5. Side docking units
6. Approach antenna
7. Working compartment
8. Working-compartment hatch
9. Central control post
10. Handrail
11. Interior panels
12. Solar cells
13. Exerciser
14. Working desk
15. Individual cabin
16. Toilet
17. Wash stand
18. Satellite repeater antenna
19. Axial docking unit
20. "Running track" trainer
21. Intermediate chamber
22. Propeller with cover
23. Target
24. Electric generator compartment
25. Hatch cover
26. Illuminator
27. Illuminator blind
28. MOB mount

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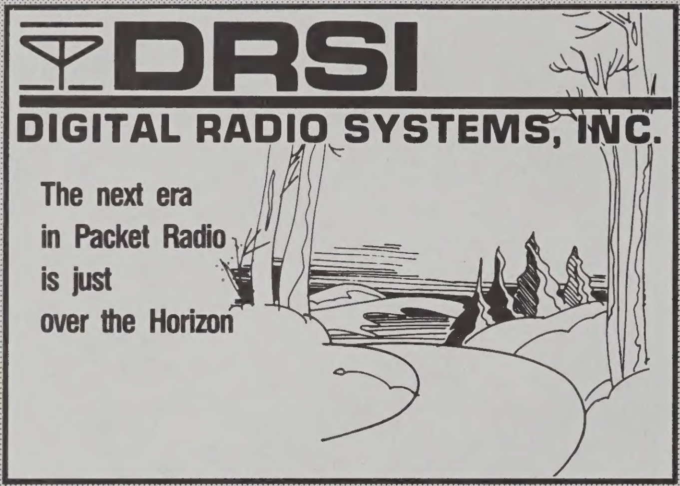
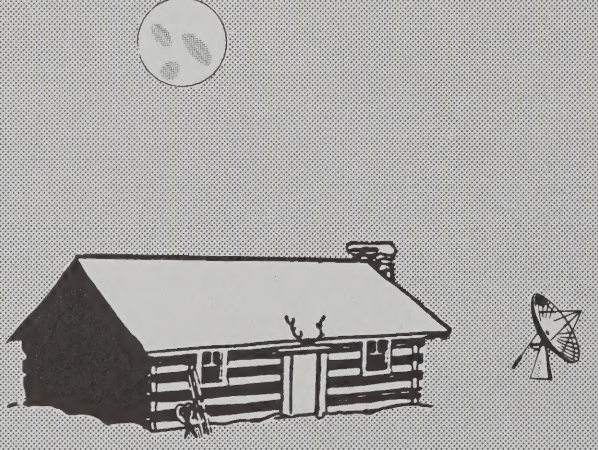
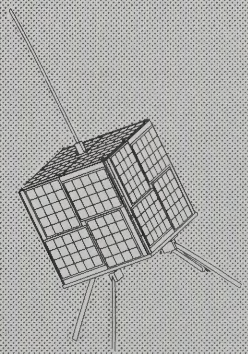
Do You Remember. . .



?

WE'RE ABOUT TO DO IT AGAIN





CONGRATULATIONS, AMSAT ON A GREAT LAUNCH!

DRSI

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The AMSAT Journal Staff is always interested in editorial contributions from AMSAT members. Text, when possible, should be on diskette (IBM compatible) with hardcopy included. AMSAT-NA reserves the right to select material for *The AMSAT Journal* based on suitability of content and space considerations. The Editor of this publication as well as editorial contributors are volunteers giving freely of their talents, time and efforts to produce *The AMSAT Journal*. Editor Joe Kasser, G3ZCZ, may be contacted at the Editorial Office listed above.

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AMSAT News

Vern Riportella Resigns From AMSAT's Board of Directors

By Ray Soifer, W2RS
VP-Special Projects

Vern "Rip" Riportella, WA2LQQ, who served as AMSAT-NA President from 1985 to 1988, has resigned from the Board of Directors. Although he did not state specific reasons for his decision, his business interests, which require him to be out of the country for extended periods, have taken increasing amounts of time, largely precluding Rip from taking an active role in most BoD matters during 1989 and 1990.

During his many years of active involvement with AMSAT affairs, Rip has been responsible for many programs of keen interest to members. He originated the AMSAT News Service (ANS), read daily by thousands, and was the founding editor (for seven years) of *ASR*. He has served as the editor of *Orbit Magazine* and has written numerous articles for *QST, Ham Radio, QEX* and *The AMSAT Satellite Journal*. For six years, he served as one of our most active net control stations. Many popular satellite operating activities, including the ZRO Tests, SatFox and ALINS, owe their origins or implementation to Rip's efforts. In short, for many throughout the world, Rip was virtually synonymous with AMSAT-NA; much of what we now take for granted would never have happened were it not for WA2LQQ. More recently, Rip has served as a key liaison person between AMSAT-NA, ARRL and the Amateur satellite program in the Soviet Union.

Throughout his long tenure as an officer and director of AMSAT-NA, Rip has always placed the members' interests foremost in his mind. For his successors in office, Rip set an example that will always be a tough act to follow.

AMSAT-NA thanks Rip for his devoted service and is proud to have him continuing as a Life Member. We hope that his time and circumstances might once again

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CQ EARTH...

(Continued from page 1)

whether he wouldn't like to do some operating on the Radio Amateur airwaves himself. Musa replied that there was no Amateur equipment on board, that he didn't have an Amateur license, and that in general no one among the crew members had operated on the air, but that, if mission control would help resolve these matters, he'd be happy to get on the air during his free time.

From that moment on, the employees of the Flight Control Center and the staff at the editorial offices of ''Radio'' magazine, began to resolve these matters. The word spread amongst Soviet Radio Amateurs that ''Radio'' employees were looking for an appropriate transceiver for the space station, and Valery Agabekov, UA6HZ, turned over his YAESU FT-290. The transceiver was delivered to MIR by the regularly-scheduled freight vehicle ''Progress-37''.

Homebrew in Orbit

Delivery of the transceiver didn't mean however that operation could begin, Musa still needed an antenna. For the sake of maintaining dependable official communications, they decided not to connect the transceiver to the existing antennas. After considering various alternatives, Musa came to the conclusion that it was necessary to put a separate antenna on the outer surface of the station's fuselage and to connect it to the existing hermetically sealed connector. To do this, an antenna had to be made and installed during an extra vehicular activity (EVA). Musa took a piece of 2mm copper wire bent it and twisted it. He then picked out a connector and soldered it to the wire.

Installing the Antenna

An EVA replace the detector unit in the X-Ray telescope took place June 30, 1988. Musa planned to use the occasion to install his homebrew antenna, which he left close to the exit hatch. However, the work outside the station lasted 5 hours and 10 minutes. Titov and Manarov completed their work having used up almost all of the resources of their spacesuits and were very tired. There was no question of installing the antenna during that EVA, and it was postponed until the next one. Making use of the forced postponement, Musa asked mission control to send up a commercially-built unit so that they would have a spare on-board.

On August 30, 1988, the regularly-scheduled ''Soyuz TM-6'' transport docked with the station, carrying an international Soviet-Afghan team consisting of Commander Vladimir Lyakhov, cosmonaut-researcher Valery Polyakov, and Cosmonaut-Researcher Abdul Akhad Momand, a citizen of the Democratic Republic of Afghanistan. After completing their program, Lyakhov and Momand returned to Earth, and Valery Polyakov, a physician by speciality, joined the permanent crew to carry out advanced medical research.

Soon after the departure of the visitors in September 1988, the freight vessel ''Progress-38'' delivered the antenna. By then, licenses had been issued to the cosmonauts so that Vladimir Titov became U1MIR, Musa Manarov became U2MIR , and Valery Polyakov became U3MIR.

While preparing for a regularly-scheduled EVA, U2MIR also prepared the antenna. He prepared and attached a handle made up of insulating tape to the base of the antenna, so that it would be easy to hold in his spacesuit glove while going through the exit hatch. As a final touch, he snipped a little red flag off from his suit and stuck it on the end of the antenna.

Installing the Antenna, continued

A regularly-scheduled EVA took place October 20, 1988 to repair the Dutch telescope. This time the work went very well and the crew had time to install the Amateur Radio antenna. From the transfer compartment, U1MIR passed the antenna to U2MIR, who worked his way along the outer fuselage of the station to the conical part of the working compartment. He then disconnected the hermetic convertor from the screen-vacuum isolation, affixed the antenna to it, and, for good measure, fastened a halyard with a hook to the handle of the antenna on one side and with another hook fastened it to the handrail located on the outer surface of the station. They were now ready to go on the air.

For some time after they first turned the set on, the trio just listened. At first all they heard was noise. The first distinct speech came through when they were flying over the United States of America. Since none of the crew had previously operated on the air, many difficulties arose. The first problem was language. The members of the crew could read and write English, but none of them were able to speak it fluently. They also had problems understanding the pronounciation of callsigns.

Recognizing these difficulties, mission control invited some Radio Amateurs to the ground control center to help the crew to the maximum extent possible, to overcome these ''childhood deceases.'' Instructions, teaching sessions, methodology, and official discussions were set up, to which Radio Amateurs came for consultations.

The First QSO

The first QSO which took place on November 8, 1988 was with Leonid (Leo) Labutin, UA3CR, operating from UK3KP, the Amateur Radio station at the newspaper ''Komsomol'skaya Pravda.'' Audio quality wasn't very good, but this was the first time. They made another QSO with UA3CR a few days later on

November 12, but this time Leo was sitting in a car outside the Marriott Hotel in Atlanta, GA with Byron Lindsey, W4BIW and operating as W4BIW/M (and being helped/watched by a host of others) at the AMSAT 1988 Space Symposium in Atlanta.

Who blew it?

Some time later while flying over the United States, U2MIR heard a conversation between two high-quality stations. Wanting to avail himself of the opportunity of entering the conversation, he broke in and gave his callsign as U2MIR. They came back and asked him who he was. He repeated the callsign. ''It's probably someone messing around'' said one to the other, and they continued their conversation, ignoring U2MIR's attempts to contact them.

On the Air

Flying over India, Musa clearly heard the callsign VU2LK — Bob and called him.

Bob was surprised, and asked what kind of callsign he was using. Musa explained that it was a Soviet Union call. ''From an airplane, right?'' guessed the operator. ''Wrong — from space!'' ''I can't believe it!'' the operator said.

It was his first contact with a cosmonaut.

Musa installed the transceiver in his cabin. Now he went on the air whenever he had free time. He gradually acquired confidence, understood callsigns more easily, and became more proficient in spoken English. The others also tried their luck, but couldn't completely overcome their fear of the microphone.

U3MIR translated for Musa what others were saying, but refrained from speaking into the microphone himself.

It didn't take long for the Amateur Radio world to know that a ham radio station was operating in orbit. Now others were calling Musa. Stations appeared on frequency more than once. Back on November 14, 1988, while flying over Argentina, he contacted Carmen, LU1UK. When she understood whom she was talking with, she exclaimed ''Wait!'' — as though the space station could slow its orbit and disappeared for a minute. A few minutes later Simon, LU6YH, called U2MIR. Carmen had telephoned him and told him to get on the air. LU6YH became a regular correspondent and one day U2MIR heard words in Russian being transmitted from LU6YH during a QSO. It turned out that Simon had invited the Deputy Minister of the Forestry Industry of the RSFSR, who was in Argentina on official business, to be present for that contact.

The large number of radio stations in the United States of America and in Europe made contacts difficult, since their signals came through as solid QRM, and only powerful stations broke through the noise in those areas.

Beyond the Urals silence set in; in this area there are practically no radio stations. It was very pleasant to work stations from the Republic of South Africa and Australia; they operated in a very disciplined fashion, although even there humorous situations arose. For example, ZS2ELL couldn't manage to get a confirmation of communication and started to call, inserting the Russian words ''na zdorov'ya'' (''to your health'') and ''pereshtroyka.'' Musa, of course, was impressed by the attempt and a contact took place.

On November 28, 1988, the joint Soviet-French expedition, consisting of Commander Aleksander Volkov, spacecraft engineer Sergei Krikalev, and Cosmonaut-Researcher Jean-Loup Chretien, a citizen of the French Republic, arrived on the MIR. Volkov and Krikalev came to relieve the basic crew. For a whole month the six cosmonauts worked together at the station, carrying out a lot of scientific research and experiments, including an EVA by the French cosmonaut.

Return to Earth

The crew was able to make over a thousand contacts with Radio Amateurs in various countries until December 21 when cosmonauts Vladimir Titov, U1MIR, Musa Manarov, U2MIR, and Jean-Loup Chretien returned to Earth. The unprecedented year long flight was over. Much more time will be needed to assess the meaning of the results of over a year of scientific research. But already the crew's contribution in setting up the ''Space — Earth'' Amateur Radio bridge can be assessed.

As a rule, a lengthy stay in a limited space has a negative psychological effect on human beings; boredom sets in. They have to find something that they are really interested in to inhibit this effect. An orderly schedule of work and rest time contributes to morale, however a long flight is a long flight. If time is perceived as the sum of days it drags by slowly. Now it is well known that when you are doing something that you are enthusiastic about, time seems to speed up. So all crews adopt important milestones and points of reference for counting off the duration of the flight. These points of reference consist of: the launch, docking with freight vehicles, meetings with visiting expeditions, EVAs, and from now on ham radio.

With the addition of the Amateur Radio station aboard the spacecraft, the communications horizons of the cosmonauts had widened. Up till then their external communications had been restricted to the Flight Control Center, even though many people (specialists, relatives, invitees, etc.) had come to the Flight Control Center to communicate with them. Amateur Radio made possible random meetings and new acquaintances. This is an extremely important factor in the psychological health of the crew during long duration spaceflight.

Now, while overflying any continent, providing they have the time, they can find someone to talk with.

The future

The radio station remained on the spacecraft, and since that precedent setting flight, U4MIR and U5MIR operated briefly. On March 9, 1990 Anatoly Soloviev, U6MIR, and Alexander Balandin, U7MIR, started operating. The STS-35 Space Shuttle flight carrying SAREX and Ron Parise, WA4SIR, is now set for May 9. The STS-35 mission commander is Vance Brand, who participated in the Apollo/Soyuz program many years ago. AMSAT-NA is trying to see if there is any suitable mutual visibility window between Columbia and MIR for a first-ever Shuttle to MIR linkup.

Whether the MIR ham radio bridge experiment will be continued will depend on the wishes of future Cosmonauts. *Ham radio is being tested aboard MIR as an important activity for contributing to the success of long duration spaceflight.* Remember that in general, just like the American Astronauts, most Cosmonauts are not Radio Amateurs. Consequently, most of the hams on MIR are new to Amateur Radio, and their reaction to being the target of a pile up may be to go QRT. Americans may speak English, the Russians may not. *If you hear MIR calling from space, remember who you are speaking to, your behaviour may influence the future of manned Amateur Radio in space.*

Notes

[1] Translation by Dexter Anderson, W4KM, and Alla Lake.

[2] Musa Khiramanovich Manarov was made a Hero of the Soviet Union for his year-long space flight.

AMSAT News

(Continued from page 3)

permit him to become more active in our affairs. If you should encounter WA2LQQ in person or on the air, we know that you will want to add your own personal words of thanks.

RUDAK-2: Launch delayed
By Peter Guelzow, DB2OS
AMSAT-DL/RUDAK-Group

The launch of RUDAK-2 and RADIO-M1 (RS-14), which was planned for 12 April 1990, is now delayed until July 1990 due to a problem in the scientific geological research satellite (GEOS). All analog and digital transponders of the new RS bird have been tested and proclaimed ready for launch.

The Downlink frequency of RUDAK-2 is 145.983 MHz with a nominal output power of 2 Watts rf PEP (max. 12 Watts). Uplinks are on 435.016 MHz for 1200 Bit/s Manchester FSK (just Fuji-OSCAR-20 and the MicroSats) modulation, 435.155 MHz for 2400 Bit/s BPSK, 435.193 MHz for 4800/9600 Bit/s RSM modulation and 435.041 MHz for Digital Signal Processing (DSP) experiments.

When the spacecraft is launched, please do NOT use these Uplink-Frequencies until RUDAK-2 is fully commissioned by the RUDAK command stations.

Detailed information about the RUDAK-2 system was published in German in the AMSAT-DL Journal. It is expected that an English translation will soon be published by AMSAT-UK, the AMSAT-NA News Service and other sources.

Operational Coordinator for Orbital Data Management Appointed

Dick Campbell, N3FKV, has been appointed AMSAT Operational Coordinator for Orbital Data Management. Dick has already assumed his initial responsibility of collecting, reformatting, and releasing Keplerian orbital data for satellites of interest to Amateur Radio operators on a weekly basis.

As AMSAT continues to progress into an era of tracking and utilizing over a dozen satellites (plus weather satellites), Dick will work to improve both our sources for this information, intermediate processing and checking, and our distribution networks to maximize the usefulness of the information for all involved.

Comments and suggestions should be forwarded to: Dick Campbell, N3FKV, 216 Coventry Drive, Lorena, Texas 76655.

Dick does not currently live near a packet BBS so packet mail on the subject of AMSAT Orbital Data Management may be forwarded to him via N5BF @ WB6YMH.

U6MIR/U7MIR QRV from MIR Space Station
By Leo, RA3AT

Soviet cosmonauts Anatoly Soloviev, U6MIR, and Alexander Balandin, U7MIR, started operation on two meter FM on the 9th of March. The best time to work them is on 145.500 MHz, after 1800 UTC and any time on weekends.

Please send QSL cards and s.a.s.e. via bureau or direct to manager UW3AX P.O.Box 679, MOSCOW 107207, USSR.

AMSAT Board Nominations

Nominations are sought for the AMSAT Board of Directors. Directors are elected by the membership for a two-year term. Any member society or group of five members can nominate someone (a member) to run for the position.

This year there are three seats to be filled. Those directors whose seats are up for election are Phil Karn, KA9Q, Tom Clark, W3IWI, and the seat vacated by the resignation of Vern Riportella, WA2LQQ.

All nominations should be sent to AMSAT BoD Nominations, 850 Sligo Avenue #600, Silver Spring, MD 20910 to arrive no later than June 15, 1990.

DOVE-OSCAR-17's On-board Computer (OBC) Experiences A Crash

On Wednesday March 14, reports were received that an On-Board Computer (OBC) crash had occurred on DOVE-1. At that time, DOVE's telemetry had changed to a continuous carrier with packet "flags".

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AMSAT HF Nets Schedule

The following is a schedule of the many AMSAT Nets each week:

DAY	TIME	FREQUENCY	NCS	COMMENT
Sunday	09:00 UTC	14.280 MHz	ZS6AKV	AMSAT-SA Net
Sunday	10:00 UTC	3.685 MHz	VK5AGR	AMSAT Australia
Sundays	19:00 UTC	14.282 MHz	WDØHHU	AMSAT International Net
Sundays	19:00 UTC	21.280	W8GQW	Simulcasts On AO-13 when in View On 145.955 Mode B
Sundays	23:00 UTC	18.155 MHz	N4QQ	Excellent DX Windows
Tuesday	9:00 P.M. EDT	3.840 MHz	W8GUS	AMSAT East Coast Net
Tuesday	9:00 P.M. CDT	3.840 MHz	WØCY	AMSAT Mid America Net
Tuesday	9:00 P.M. PDT	3.840 MHz	KI6QE	AMSAT West Coast Net
Saturday	15:00 UTC	28.460 MHz	WB2YGA	AMSAT Beginner's Net
Saturday	10:00 UTC	14.280 MHz	PAØDLO	AMSAT European Net
Saturday	22:00 UTC	14.282	ZL1WN	AMSAT South Pacific Net

Using the G3RUH 1200 Baud PSK Modem with the AEA PK-232

By Ross W. Forbes WB6GFJ @ N6IIU (President, Project OSCAR, Inc.)

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Introduction

My shack currently contains four G3RUH modems. Two are dedicated to my UoSAT-OSCAR-11 DCE work, the third is the 400 BPS PSK modem for AMSAT-OSCAR-13, and I have just recently finished constructing a 1200 baud PSK modem for use with Fuji-OSCAR-20 and the MicroSats. All of these modems feed into a PC XT clone RS-232 serial port and are built to the original unmodified design supplied by G3RUH, with the exception of one change in the 1200 baud PSK modem instructions.

Since the MicroSats and Fuji-OSCAR-20 were launched earlier this year, I want to pass along a few thoughts on building the G3RUH 1200 baud modem which might help others about to build the same modem.

Building The Modem

The G3RUH 1200 baud PSK modem can be purchased as a box of parts along with the printed circuit board from RadioKIT in Pelham, NH. You may also obtain the printed circuit board (and instructions) direct from AMSAT-UK. However, if you purchase the PCB alone, you must gather your own parts. The good news is that two sources should be able to supply 99% of the parts, including all of the chips. The two sources of parts where I obtained my parts from are Dick Smith Electronics (by mail) and Active Electronics (mail order or walk-in). Addresses for all sources are given in this article.

When you build the modem you must have the proper tools. Besides the usual needle nose pliers, diagonal cutters, wire strippers, etc, you really should have a pencil tip soldering iron. Leave your huge soldering GUN on the shelf! A good pencil tip soldering iron is available from Radio Shack. The part identifiers from the 1990 catalog are:

Cool Grip Handle #64-2078, Heating Unit (23 Watts) #64-2081, Tips #64-2064

In the package of soldering iron tips, you need to use the rounded tip, that looks something like a pencil. Don't use the flat tip (looks like a screw driver) nor the large tip. The small, rounded tip will work for the PSK modem without any trouble, *If you take your time* and are *careful!* Don't rush your work; *Take your time!*

It took me about seven days to wire up the PSK modem. Since I am busy rebuilding our home after severe damage in last October's earthquake, spare time is not in abundant supply for me. However, by taking my time, the board went together without any trouble. Alignment of the modem was performed with a scope and a frequency counter borrowed from K6AL. As long as no wiring errors are made, you only have to align three trim pots, and set two or three jumpers; depending on your particular equipment.

Alignment instructions supplied with the kit were more than adequate. However, you might also want to locate a copy of the original article that appeared in the February 1987 issue of *Ham Radio Magazine.* There are a few subtle comments in the *Ham Radio* article that seemed to clear up the minor question I had. The original G3RUH instructions called for a frequency readout of 1500 Hz on TP1, and I was able to get my aligned to 1501 Hz; close enough I believe!

My OSCAR station has an ICOM IC-475 on the Mode J downlink, so I had to jumper LKI as specified. The "auto tuning" control is brought out of pin J4-5 to the Up/Down pin on my IC-475 microphone socket and follows the MicroSat Doppler very well. By the way, each time up/down buttons are pressed on the IC-475, you move the radio by 50 Hz. Your read out on the IC-475 only goes down to 100 Hz resolution, so at times your frequency will change, but that fact will not be indicated on the digital readout.

Connecting the G3RUH 100 baud PSK Modem to the AEA PK-232

In order to use the G3RUH 1200 baud PSK modem, you need to connect it to your packet TNC. I have an AEA PK-232. However, the instructions supplied with the PSK modem refer to a modem disconnect header. TAPR recently released a PK-232 modem disconnect upgrade kit for about $20. This was purchased in mid January 1990 and installed per the TAPR instructions without any problems. The key to that success was using the proper soldering iron, and taking lots of time to do the work.

Once the TAPR/PK-232 modem disconnect header is installed, you are ready to connect the G3RUH 1200 baud PSK modem. The one *minor correction* I referred to earlier will be necessary when you connect the two units together. All of the pins specified in the G3RUH instructions are correct except for one. The G3RUH specifications call for the TXClock data to be on pin 12 of the modem disconnect header. On the TAPR/PK-232 modem disconnect header the required TXClock data is on pin 14; this is clearly indicated in TAPR's instructions! Therefore, in order to connect the G3RUH 1200 baud PSK modem to the TAPR/PK-232 disconnect header, use the pin assignments Shown in Table 1.

Normally pins 17 and 18 are jumpered. The G3RUH 1200 baud PSK modem clearly indicated this jumper should be remov-

TABLE 1 G3RUH Modem / PK-232 Cable Pin Assignments

G3RUH 1200 baud Modem Pins	TAPR/PK-232 Modem Disconnect Pins
J2-12 (TXClock)	Pin 11
J2-15 (Ground)	Pin 15
J2-17 (RXData) [Wire this to Pin J of Switch S3c on the] [G3RUH 1200 baud PSK modem schematic]	
Wiper of Switch S3C	Pin 17
[To Pin N on Switch S3c]	Pin 18
J2-19 (TXData)	Pin 19

The following pins on the TAPR/PK-232 Modem Disconnect Header must be jumpered:

1 to 2, 5 to 6, 13 to 14, 19 to 20

ed since it goes to switch S3C to place the PSK modem in or out of the data path. This wiring instruction is correct.

On the printed circuit board, there is a jumper called LKC. This should be wired for a TNC-1. The instructions provided by G3RUH explains the jumper is used by the PSK modem as it relates to the clock speed of your packet TNC. For a PK-232 be sure to wire LKC for a TNC-1.

One omission from the schematic I overlooked was the lack of a power on/off switch. In my own station I run individual power to each unit, so a power switch is necessary. If you want to control the power this way, be sure to drill an extra hole for a power switch while you do all your original metal work.

Collecting PSK Data with the G3RUH 1200 baud PSK Modem

Prior to the first orbit of MicroSat, I had the PSK modem working with the PK-232 without any trouble. Audio was taken from my IC-475 and fed into the PK-232 via the normal audio jack. Switch S3 on the G3RUH modem was placed in the ''satellite position.'' The PSK signal was tuned in so the LOCK light was on, then I turned on the auto-tune switch and watched data fly by! It helps if you increase the threshold control on the PK-232 so the DCD light stays on continuously. PSK data will now pass through the PK-232 to your computer for collection.

To receive initial PSK data, I used my normal packet program; LAN-LINK. I adjusted the terminal parameters to read all traffic on the frequency, and MicroSat data appeared on my screen. It was not necessary to adjust any TNC parameters to copy the data. The only extra step I performed was to be certain I was saving all collected data to disk; with LAN-LINK this means pressing the F1 key to start ''CAPTURE TO DISK.''

As you get used to MicroSat, you will notice the LOCK light on the G3RUH PSK modem will go on at two or three spots as you turn across the PSK signal. If you are tuned to the correct spot, data should appear on your screen within seconds; if not, change to another frequency that locks. Another error I made was leaving my IC-475 on the wrong sideband. When on the correct sideband (Upper in my case) the auto-tune function of the modem works perfectly. If you are on the wrong sideband, the auto-tune function will go in the opposite direction. Once you learn this, you won't make the mistake again since you will always leave your rig on that sideband.

Using the G3RUH 1200 baud PSK modem on transmit is straightforward. One error that I made was to connect the TXCLock to the 1200 Hz circuit of the PK-232. This is NOT correct, and of course the PSK modem would not work on transmit. Cliff Buttschardt, W6HDO, was a big help locating this error, and once he explained I should connect the TXClock to pin 11 on the modem disconnect header, the uplink modulator took right off and worked perfectly! I was able to connect to myself using the loopback test described in the instructions. Later, I was able to connect with myself via AMSAT-OSCAR-16 (PACSAT-1). Therefore, the G3RUH 1200 baud modem works well with the AEA PK-232.

One piece of advice learned that might be important to others: My PK-232 has the PK-232MBX (Mailbox) daughter board. After I had the PSK modem properly aligned and connected to the PK-232, I was not able to connect with myself until I adjust one of the parameters on the PK-232. The default parameter for the CUSTOM command is $0A15. I changed the CUSTOM command to become $0A14. After that single parameter was changed, I had no trouble connecting with myself on the loopback test.

On PACSAT-1 I used the following parameters:

FULLDUPLEX	ON
FRACK	3
TXDELAY	0
CUSTOM	$0A14
MON	6
MCON	6

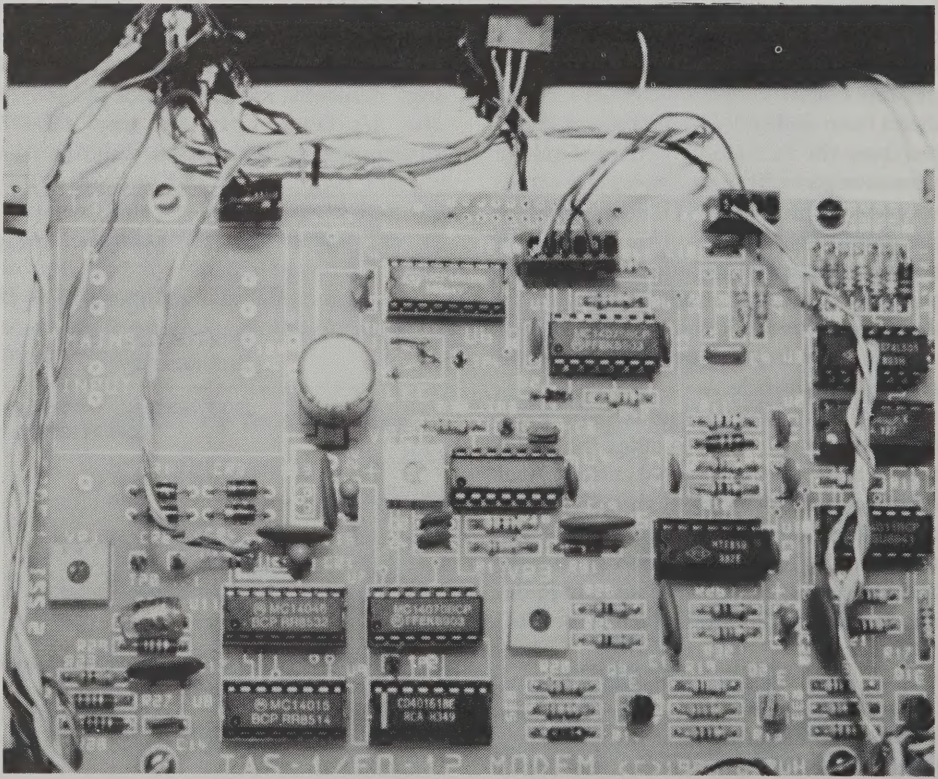
The last two commands (MON and MCON) will allow you to see everything going on while you are connected. Once you get used to the operation of your modem, you will want to reset MON and MCON to a lower value to reduce the amount of extra information that appears on your screen.

Summary

This article should assist anyone building the G3RUH 1200 baud PSK modem especially for working with the PK-232. You now know where to obtain your parts, how to obtain a proper modem disconnect board, and how to receive PSK data. By the way, using your packet program to receive PSK data will leave you with an ASCII file. This file may or may not be compatible with data processing programs that may have come out, or will come out in the future. However, with your PSK modem now working properly with your PK-232, you only need to use a different program if you wish. The output of my PK-232 has been captured with LAN-LINK as well as version 1 and version 3 of Bob McGwier's TLMDC.EXE program. Since the purpose of this paper was to discuss the G3RUH 1200 baud modem and the PK-232, I'll leave it to others to review various telemetry programs.

Good luck, and if you are having problems building the G3RUH 1200 baud PSK modem, I will try to answer any questions. *Please include an S.A.S.E.* with your letter and expect to wait for a reply; I am still busy rebuilding from the earthquake.

(Continued on page 14)



The UoSAT-OSCAR 14 and 15 Spacecraft

Compiled by Joe Kasser G3ZCZ, from material provided by AMSAT-UK, Martin Sweeting, G3YJO @ GB3UP, and Jeff Ward, GØ/K8KA @ GB3UP.

UoSAT-OSCARs 14 and 15 were placed together with AMSAT-NA's four MicroSats on a new Ariane structure (known as the Ariane Structure for Auxiliary Payloads (ASAP) specially designed to provide small secondary payloads with inexpensive launch opportunities on a mass available basis. This article provides some information about the UoSAT spacecraft.

Mission Objectives

The mission objectives of the UoSATs are to support:

1) Amateur Radio packet communications using low Earth orbit (LEO) satellites,

2) the advancement of store-and-forward communications technology,

3) studies of the orbital radiation environment and its effects on semiconductors,

4) in-orbit demonstration and evaluation of novel spacecraft technologies,

5) development of low-cost CCD Earth imaging techniques,

6) refinement of low-cost computer controlled spacecraft attitude determination and control systems providing precision Earth pointing.

Spacecraft Description

The two UoSAT spacecraft are structurally identical, and have identical housekeeping subsystems, but carry different payloads. UoSAT-OSCAR-14 carries an Amateur Radio digital store-and-forward communications transponder operating in the Amateur satellite service, and will also investigate the effects of the space radiation environment on spacecraft components. The payloads on UoSAT-OSCAR-14 are funded by the University of Surrey, the Royal Aerospace Establishment (UK), Volunteers In Technical Assistance (VITA) (USA), and AMSAT-UK. UoSAT-OSCAR-14 carries Gallium Arsenide solar arrays in collaboration with Mitsubishi (Japan) and NiCd batteries in collaboration with Larry Kayser's group in Canada.

UoSAT-OSCAR-14 Packet Communications Experiment

The primary payload on UoSAT-OSCAR-14 is the Packet Communications Experiment (PCE). The PCE is an orbiting packet node with 4 Mbytes of message storage space and continues the Digital Communications Experiment (DCE) of UoSAT-OSCAR-11. The PCE system (hardware and software) was developed under a contract from the VITA, who hope in the future to use store-and-forward communications as a link with development workers in remote areas. The flight of the PCE on UoSAT-OSCAR-14 and its use by Radio Amateurs is funded by the University of Surrey and AMSAT-UK.

The UoSAT-OSCAR-14 PCE uses 9600 bps frequency-shift-keyed (FSK) uplinks and downlinks. The spacecraft operates in Mode J: with one uplink in the two meter band and a downlink in the 70 cm band. RF communications links should be good enough to provide a consistent service to groundstations with an AMSAT-OSCAR-13 style 10-13 dBi gain antenna and 10 Watts to access the spacecraft *at the horizon* or the conventional 100 Watts to an omni-directional antenna. An experimental high-power downlink mode for very-small groundstations also exists.

Whilst the UoSAT/AMSAT-UK PCE uses standard AX.25 communications links, it also provides a platform for experimentation with higher-level packet communications protocols. Current 'PACSAT' systems employ ALOHA access (each station transmitting when it wishes to) and user interfaces based on terrestrial BBSs. The PCE employs experimental access techniques aimed at more efficient machine-to-machine communications. The user-friendly BBS-like interface will be on the ground, in the groundstation's personal computer or TNC. The groundstation and the satellite will communicate using high-level protocols, making the best use of short satellite passes.

A ground station for the PCE must have a 9600 bps PSK modem compatible with the G3RUH modem standard. This modem should be connected to a Mode J satellite station: 145.975 MHz uplink and 435.070 MHz downlink. This modem and RF equipment must be connected to a packet TNC. Ground station antenna and RF power requirements should be no different to those required for the AMSAT-NA MicroSats. To access the PCE Packet Bulletin Board System (PBBS), you will need software running high-level protocols under development by Jeff Ward, GØK8KA, and Harold Price, NK6K, in your ground station computer.

This system — requiring you to connect your TNC to a host program and not just to a terminal emulator — will provide a powerful electronic mail service eliminating many of the frustrations experienced by users of the existing ground-based PBBS network (The same PACSAT protocols will also be implemented on the AMSAT-NA MicroSats — although NOT at 9600 bps.).

Current plans call for full details of the PACSAT protocols to be published as soon as they are available. A Broadcast Protocol specification (for transmission of bulletins, etc.) has already been published in the proceedings of DATASPACE '89. When published, the protocol specifications will allow software authors to begin implementing the PACSAT Ground Station Software for different computers. It is also likely that a PACSAT Ground Station Software implementation for IBM-PC compatible computers will be produced by UoSAT and AMSAT-NA and made available to other Amateurs.

The PCE is controlled by an 80C186 microprocessor running at 8 MHz.

The 80C186 is a highly integrated microcontroller with an integral direct memory access (DMA) controller, an interrupt controller, timers and other peripherals. With a full 16-bit bus running at such a high speed, this processor has adequate computing power to control all of UoSAT-OSCAR-14's housekeeping concurrent with the packet radio communications system.

The UoSAT/AMSAT-UK PCE will be at one end of the spectrum of Amateur satellite store-and-forward communications systems. By mid 1990, Radio Amateurs will be able to select a "PACSAT" facility which best suits their communications needs and capabilities, ranging from UoSAT-OSCAR-11, Fuji-OSCAR-20, the AMSAT-NA MicroSats and UoSAT-OSCAR-14.

Cosmic Particle and Total Dose Experiments

The Earth's magnetic field and atmosphere shield the surface of our planet from much of the radiation emitted by the sun and other cosmic sources. Satellites in orbit, however, are not protected by this atmospheric and geomagnetic shield and do receive high levels of cosmic radiation.

In addition, particles trapped in the geomagnetic field oscillate between the magnetic poles in the Van Allen radiation belts and further increase the radiation received by objects in orbit. Thus, satellite electronic subsystems are in a much harsher radiation environment than terrestrial systems.

Radiation damage is the primary threat to a satellite's electronic systems once the satellite has survived the rigors of launch. Effects due to the total dose of radiation absorbed by on-board semiconductors causes them sooner or later to fail permanently, as happened to the AMSAT-OSCAR-10 Integrated Housekeeping Unit (IHU). Less dramatic but equally serious are the temporary effects of energetic cosmic particles entering semiconductor memories. These particles cause Single Event Upsets (SEUs) — changing the contents of memory bits. This can cause computers to crash or stored data to be corrupted. As satellites become more sophisticated they also become more reliant on microprocessors, peripherals and memories, and as more functions are placed on smaller and smaller ICs, the ICs become increasingly radiation sensitive. Measurements of radiation levels experienced by satellite systems in space, and observations of radiation effects on satellite electronics, help designers evaluate new semiconductor technologies and select the optimal components for future satellite missions.

With this in mind, the UoSAT Unit has conducted a series of in-orbit radiation experiments over the last seven years. UoSAT-OSCAR-9 carried Geiger detectors for measuring radiation, and the On Board Computer (OBC) had an SEU counter on its memory. On UoSAT-OSCAR-11, monitoring radiation effects was taken a step further. The Particle Wave Experiment monitors the electron flux spectrum at eight energy levels. The 1802 OBC has an SEU counter, while the Digital Communications Experiment (DCE) and Data Store and Readout (DSR) monitor SEUs in a total of 300 kbytes of memory. UoSAT-OSCAR-11 is currently involved in a long-term experimental program supported by ESA to investigate the statistics governing SEU's.

UoSAT-OSCAR-14 will continue this series of experiments with a Total Dose (TDE) monitor and a Cosmic Particle (CPE) detector. The TDE will provide, for the first time, direct measurement of the absorbed radiation dose at various points in the satellite. This will allow assessment of the shielding provided by the satellite structure. The TDE uses seven radiation detecting field effect transistors (RADFETs) monitored by an 80C31 microcontroller.

The CPE detects cosmic particles as they pass through a diode array. As particles pass through the diodes, they deposit charge, which is measured by a charge integrator circuit, again interfaced to the 80C31. The measured charge can reveal the energy of the particle and the angle at which it entered UoSAT-OSCAR-14. This CPE/TDE package, along with SEU monitoring on the 4 Mbytes of PCE memory will significantly increase the amount of information available to designers of computer systems for future satellite use.

The CPE/TDE will send its data to a 'file' in the PCE, where it will be downloadable by Amateurs using the PCE who wish to follow the radiation experimentation. The CPE/TDE is funded by the Royal Aerospace Establishment and built in conjunction with the Harwell Laboratory (UK).

On-Board Data Handling

UoSAT-OSCAR-14 carries a standard UoSAT 1802 OBC to assist the 80C186 as necessary. Both computers are interfaced to a central telemetry system monitoring 32 analog channels throughout the satellite. Telemetry is interfaced directly to the downlink through hardware interfaces, or it can be gathered by the 80C186 and presented as AX.25 packets. This combination results in a failure-resilient system with the flexibility of computer-driven packet telemetry backed-up by an all-hardware system.

The three microcomputers on UoSAT-OSCAR-14 (1802, 80C31, 80C186) are linked to each other and to the uplinks, downlinks, telemetry and telecommand interfaces through a multiple access serial data-sharing bus. This bus eliminates many of the dedicated serial links used in UoSAT-OSCAR-9 and UoSAT-OSCAR-11, without eliminating the redundant data paths which are available should the primary paths fail. The bus interface is a simple circuit that can be added to any UART serial chip.

Attitude Control & Stabilization

UoSAT-OSCAR-14 is an Earth-pointing satellite, using a gravity gradient boom augmented by computer controlled magnetorquing. This system, which uses no continuously-moving parts or expendable fuels, is ideal for small, inexpensive satellites in low-Earth orbit. UoSAT-OSCAR-11 has maintained a pointing stability of within 5 degrees using this system, and it is hoped that improved algorithms and increased computing power available on UoSAT-OSCAR-14 will result in even better results. Satellite attitude is calculated from magnetometer measurements of the Earth's local magnetic field. UoSAT-OSCAR-14 carries a flux-gate magnetometer measuring the geomagnetic field in the satellite's three axes. A direct interface to the 1802 and 80C186 OBCs provides resolution to 8 nanoTesla over a 100 microTesla range, whilst a slightly reduced resolution is also available through the satellite's standard telemetry system.

UoSAT-OSCAR-14 and UoSAT-OSCAR-15 Modular Design

The two spacecraft are built around the modular design concept developed for the UoSAT-C project. The modular concept proved itself when changes in the NASA/USAF launch manifest resulted in the postponement of the University of Surrey's UoSAT-C mission, originally scheduled for launch on a NASA-DELTA rocket in late 1988.

When the University of Surrey signed final agreements with Arianespace for the launch of two UoSAT satellites and the MicroSats on an Ariane along with the SPOT-2 primary mission, many of the mechanical and electrical subsystems built for UoSAT-C could be simply taken apart and reassembled in a different order to build UoSATs D and E which became UoSAT-OSCAR-14 and 15.

The UoSAT-OSCAR-15 satellite is based on an identical 'bus' to UoSAT-OSCAR-14; OBC, telemetry, telecommand, power generation and conditioning, and mechanical structure are the same. The compliment of payloads and experiments, however — funded by the European Space Agency, the Royal Aerospace Establishment (UK) and the University of Surrey — is different. UoSAT-OSCAR-15 is primarily a technology demonstration mission, flying the Transputer Data Processing Experiment (TDPE), Solar Cell Experiment (SCE) and the CCD imaging system which were to fly on UoSAT-C.

The Transputer Data Processing Experiment

The TDPE is a parallel computing system based on three Transputer parallel processing microcomputers. The three Transputers can be used in parallel on different parts of a single task simultaneously, greatly improving computing speed. They can also be used to monitor one another, watching for erratic behavior which might result from radiation induced SEUs. Both the increased performance

of the parallel processing arrangement and the increased reliability of the 'watch-dog' arrangement will be studied.

Results of this study will be used by the European Space Agency Technical Labs (ESTEC) in the design of high-performance On-Board Data Handling systems for future satellites.

Advanced Solar Panel Technology

The UoSAT-OSCAR-15 Solar Cell Experiment comprises an array of solar-cell samples from several manufacturers which will be constantly monitored for changes in performance caused by radiation, temperature, and other environmental effects. The cells represent the complete range of solar generator technologies under development: Gallium Arsenide, Indium Phosphide and Silicon. The cells are covered by various cover slides designed to enhance panel efficiency and/or reduce panel degradation due to radiation.

The SCE is mounted on a panel that replaces part of a solar panel on the side of the UoSAT-OSCAR-15 spacecraft.

The SCE monitoring system will wait until the sun is directly upon the SCE, and then make a series of 100 current/voltage measurements on each cell sample. These data will be sent in a burst to the satellite's 1802 OBC, for storage and later transmission to the ground.

In addition to the SCE, UoSAT-OSCAR-15 carries the first Gallium Arsenide solar arrays manufactured by FIAR/CISE (Italy) and EEV/MSS/RAE (UK).

CCD Camera Imaging Experiment

The CCD camera continues the series of UoSAT experiments with low-cost Earth imagers on satellites. UoSAT-OSCAR-9 carried one of the earliest two- dimensional CCD arrays — certainly the first low-cost CCD camera in orbit. The results from this imager were spectacular when one considers the novelty of the technology, although the fact that UoSAT-OSCAR-9 is not stabilized pointing towards the Earth makes the imaging somewhat random. The UoSAT-OSCAR-11 CCD camera on the other hand is a high-sensitivity system intended to take images of the auroral oval as UoSAT-OSCAR-11 passes over the poles. It is connected to two 96 kbyte memory banks with serial readout and error-detection-and-correction coding. Unfortunately, results from UoSAT-OSCAR-11 have been mysterious, and it has so far proved difficult to adjust the sensitivity of the camera to retrieve readily-identifiable images.UoSAT-OSCAR 15-carries a more recent CCD camera, optimized for meteorological scale imaging. The Earth surface resolution of the system will be on the order of 1-2 km, with a field of view 1000 km square. The inclusion of this system on UoSAT-OSCAR-15 is a response to widespread interest in medium resolution imaging for low-cost meteorology satellites.

UoSAT-OSCAR-15's camera will generate a 96k byte raw image, which will be sent to the TDPE, where the parallel processors will compress the image onboard the satellite ready for transmission to ground. The data compression stage will provide between 50 and 90 percent reduction in the amount of memory required to store an image, which will also decrease the downlink time required to transmit a picture to a groundstation.

Operations Following the Launch

In the early days of the OSCAR program, once a spacecraft was in orbit, everything was ready and all we had to do was use it while the ground command stations made sure that the satellite stayed healthy. Things are very different these days. First the spacecraft have to be stabilized and then experiments have to activated, something that requires ongoing operations.

UoSAT-OSCAR-14 Operations

UoSAT-OSCAR-14 operations for the month of February concentrated on maneuvering the satellite into an attitude suitable for extension of the gravity gradient boom. On UoSAT-OSCAR-9 and UoSAT-OSCAR-11, these preliminary attitude control operations had been conducted mostly under direct control of the Surrey Command Station, with only simple on-board computer programs. These operations are being conducted autonomously aboard UoSAT-OSCAR-14, by the 1802 OBC. This change from manual to automatic control has been made possible as a result of extensive experimentation using UoSAT-OSCAR-11, and the development of complex autonomous attitude determination and control algorithms for the FORTH DIARY.

These operations have been going well, if a bit slowly. UoSAT's attitude determination and control expert, M. Hodgart, has extensive lecturing and administrative commitments at the University, so software modifications and data analysis have sometimes been delayed.

Earlier in February, UoSAT-OSCAR-14 was noted to be in a ''flat spin'', with the spin axis lying in the orbit plane, roughly north/south pointing. The first step in the attitude determination processes was to slow this spin down from once every 18 seconds to once every several minutes. Once the flat spin was slowed, controllers decided to impart some spin about the satellite's Z axis. This is to be the normal spin mode for UoSAT satellites so as to make sure that the sun shines evenly on all of the spacecraft's body mounted solar panels. This spin assures that no undesirable thermal gradients build up across the body of the satellite. Although control of Z axis spin is a regular part of UoSAT-OSCAR-11 operations, it was found that spin control of a non-Earth-pointing UoSAT required some modifications to the software. The desired Z axis spin rate was achieved during the last week in February.

Next, the Z axis had to be locked to the Earth's magnetic field. Because of the alignment of the field, magnetic locking places the satellite in a favorable attitude for boom deployment as it makes descending passes over Guildford, Surrey. Thus, once the satellite will have locked to the magnetic field, the boom will be deployed when the spacecraft will be within range of the Command Station, the magnetic lock software will be disabled, and the satellite should then become gravity gradient stabilized.

Maneuvers prior to gravity gradient stabilization took somewhat longer than expected. Delays were caused by the need to add digital filters to the attitude determination software to remove unwanted noise from the magnetometer readings.

Data Formats

UoSAT-OSCAR-14 continues to run the FORTH DIARY on the 1802 OBC, using data formats distributed just after launch. The development, publication and implementation of downlink data formats for the UoSATs is a delicate business, especially early in a mission. AMSAT-UK do not want to publish data formats if they are likely to change quickly, lest people waste their time implementing software which will later become useless. On the other hand, if they do not publish formats, you can't tell what is happening to the satellites.

High Speed Downlink Tests

The UoSAT Command Station conducted limited experiments with the 9600 bps Frequency Shift Keyed (FSK) downlink on UoSAT-OSCAR-14 in early March. These tests were successful, doubling the highest digital link speed previously used on any OSCAR satellite (4800 bps is routinely used on UoSAT-OSCAR-11).

Data transmitted during these tests was either asynchronous telemetry from the Very Large Scale Integrated telemetry system or continuous streams of 1 bits (no data at all). The "stuck ones" tests are very useful because of the scramblers in the modulator and demodulator. The 1's are scrambled and transmitted as pseudo-random data over the RF link. The ground-station demodulators then lock onto this data, descramble it, and reproduce the continuous 1's. Any 0's in the demodulated output data stream are caused by bit errors on the communication link, and the link bit error rate (BER) can be calculated from the number of such transitions.

BER tests are to be scheduled into the DIARY to help those trying to test their FSK receive systems. The first such tests were scheduled for the morning passes over the East Coast of the USA on March 15, 1990.

UoSAT-OSCAR-15 Operations

Unfortunately contact with UoSAT-OSCAR-15 was lost shortly after launch. Losing UoSAT-OSCAR-15 meant that AMSAT-UK had to expend unanticipated resources to try to find out what went wrong, and if it would be possible to try and recover some or all of the spacecraft.

During the middle of February 1990, experiments took place using a large (150 ft) antenna at the Stanford Research Institute (SRI) to attempt to detect the very low level signals leaking from the UoSAT-OSCAR-15 uplink command receiver local oscillators (LO). If the spacecraft power systems are functioning, then these signals should always be present because the receivers cannot be switched off. However, conforming to good engineering practice, these leakage signals were deliberately minimized during the design of the satellite and so are very weak (-60 dBm or one thousand, millionth of a Watt).

The work at SRI was very time consuming, requiring azimuth and elevation control of the huge Stanford 150 foot diameter dish to within tight limits.

A one second error in antenna tracking time may cause the big antenna to miss the satellite altogether. Data can only be collected for a few seconds at a time. Each pass is followed by hours of post-pass-processing. It is only possible to extract the signals from the background noise using sophisticated off-line fast Fourier transform (FFT) signal processing.

Luckily UoSAT-OSCAR-14 was working well so that this sister satellite could be used as a 'reference'. Since both of them use identical receivers, if signals from UoSAT-OSCAR-14 could be detected, then it was likely that the big antenna would also be able to copy the similar signals from a powered but for some reason silent and non-responsive UoSAT-OSCAR-15.

After much processing, SRI successfully detected the leakage signal from UoSAT-OSCAR-14 on 26 February at the expected levels, and then began attempts to listen for UoSAT-OSCAR-15 and succeeded in detecting the LO leakage on March 10 and then heard it again on March 11.

Now that AMSAT-UK know that UoSAT-OSCAR-15 is not completely dead, they can begin to try to find out what is wrong. They can't just go up there and make a service call. Each UoSAT carries three receivers: a fixed-frequency command receiver and two communications receivers with switchable frequencies.

Efforts will now concentrate on monitoring the local oscillators of the switchable frequency receivers. If one of these receivers can be heard, commands will then be uplinked to change the receiver frequency, which should cause a corresponding change in the LO frequency. Observation of a changed LO frequency will confirm that the satellite's command system is basically healthy, and the process will continue to try to determine the problem.

Updates to the UoSAT and MicroSat status will be published in *The AMSAT Journal* and via packet radio bulletins.

Dear Joe...

This space is reserved for your comments.

Antennas for MicroSat Ground Stations

Dear Joe: About Dick Jansson's paper in the last issue of the *Journal*, and the article by Courtney Duncan on visibility of LEO satellites that he references. They are two excellent and insightful jobs! Actually, many years ago I took a K2ZRO Satellabe and tried to do for myself graphically what Courtney has done with a computer, showing that AMSAT-OSCAR-6 spent about half its time below 10 degrees elevation and about 90 percent of its time below 30 degrees elevation. As Courtney and Dick have pointed out, those proportions increase greatly for lower-altitude birds such as manned spacecraft and MicroSats.

It's time we gave that sorry excuse for a satellite antenna, the crossed dipoles above ground screen, a decent burial. I still see articles about it and keep pitying those who build them and wonder why their performance is so poor most of the time (except when the satellite is at elevation angles above 30 degrees or so). Better yet, don't destroy the whole antenna, just get rid of the ground screen. Take the crossed dipoles, get them up in the air as high as possible to improve their performance at low elevation angles, and let them function as an omnidirectional, horizontally-polarized, unity-gain antenna in the horizontal plane. At high angles, you will get circular polarization, albeit without a lot of gain. However, you'll find that you don't need much of an antenna at high angles because the satellite is closer and the inverse-square law increases the signal strength.

As an alternative antenna, the old-fashioned, vertically-polarized ground plane antenna, with a quarter-wave radiator above four horizontal radials, will produce even better low-angle performance and be just as omnidirectional. As with the turnstile, it should be mounted in the clear, but it need not be as high above the ground for best results.

Either antenna should be good for the MicroSats. As for manned spacecraft, I hope everybody uses an omnidirectional antenna because I'm going to use my 19-element, 3.2-wavelength Yagi pointed at the horizon without elevation control, the same one I worked WØORE and MIR with. For manned spacecraft (unlike MicroSat), the more antenna gain, the better; it reduces the QRM which you hear on the astronaut's frequency, it boosts the received signal from the spacecraft and it also permits you to overcome the "silent pileup" effect at the spacecraft (which occurs because the spacecraft receiver hears numerous FM signals, none of which is strong enough to produce capture). It also permits you to lower your transmitter power and reduce the QRM for those around you (if they can hear the spacecraft through the QRM, maybe they won't be transmitting when you are trying to hear it). Just remember, who was the first Amateur to work a manned spacecraft (W5LFL)? It was Lance Collister, WA1JXN. What was he using? A 16-Yagi EME array!
Ray Soifer, W2RS

Land-line and packet BBS

Dear Joe: Allow me to bring to your notice a land-line and packet BBS in the Los Angeles area. It is an effort by John Winiowski, N6DBF, to do something constructive ahout the AMSAT BBS situation. In my view his BBS has surpassed the one

belonging to the Dallas Remote Imaging Group. John's BBS is also connected with Astronomers, but is not nearly as busy.

The phone number is (714) 738-4331. The BBS is located in Fullerton and is hosted by the Orange County Astronomy Club. It carries AMSAT News and Keplerian elements, NASA elements and much more. All files are updated weekly. The satellite files are in area ''H''. The BBS is on-line 24 hours a day, 7 days a week, is free to users, and has 2400 baud capability. On packet N6DBF carries the AMSAT Keplerian elements and is QRV on 145.030 MHz. 73 — *Cliff Buttschardt, W6HDO*

News from France and Germany

Dear Joe: I've just gotten copies of *Radio,* the monthly publication of the French Amateur Radio Society REF, and the *AMSAT-DL Journal.*

On pages 11 and 12 of *Radio* is an article about the general meeting of RACE, their equivalent of AMSAT, which was held in Toulouse on 30 September 1989.

While my French is at the mediocre level, I can tell you the following: The ARSENE satellite is still alive. It will have a Mode B packet (3 uplink, 1 downlink channels) transponders and a linear Mode F (435 uplink, 2450 downlink) transponder. It will be launched by Arianespace with the Telecom 2B satellite in 1992. Part of the construction will be performed by Motorola Bordeaux, with the remaining work to be done in the Paris region. Working models are expected to be completed in the June/July 1990 time frame.

I'm getting the article translated, and will send it to you for inclusion in a future (the next?) *Journal.*

The AMSAT-DL Journal is almost entirely filled with RUDAK-2 news. It has a picture of the satellite on the cover, along with lots of pictures of the AMSAT-DL ''crew'' at home and in the USSR with their Russian counterparts.

Articles cover every aspect of RUDAK-2, starting with an overview of RUDAK-2 by Hanspeter Kuhlen, DK1YQ, through detailed articles by Karl Meinzer, Werner Haas and others on the software, hardware and seemingly every other aspect of this spacecraft. I have heard that Don Moe is translating the articles. I hope so...

Here are some details on the spacecraft that I've been able to decipher:

RUDAK-II is part of the RADIO-M1 satellite, a joint project of AMSAT-U-ORBITA, Molodetschno, USSR (the M in M1 stands for Molodetschno), the Adventure Clubs, Moscow, and the AMSAT-DL RUDAK Group, Marburg/Munich/Hanover.

Launch: 12 April 1990 from Plesetsk on a Proton rocket
(Editor's note: Delayed - see AMSAT News)
Satellite: part of a GOES (Russian geological forecasting?) satellite
Orbit: Sun synchronous, 1000km elevation; period = 105 minutes; 98 degrees inclination

Linear and regenerating transponders:

Linear Transponder	(Uplink)	435.030 - 435.120 MHz
Linear Transponder	(Downlink)	145.880 - 145.970 MHz

Rudak II 2 computers using the IPS operating system for AX.25 packet radio (Mailbox, DSP experiments); 1MB Ram disk

Sat-RX-1 435.016 MHz +/-10 kHz 1200bps/FSK/NRZIC (Bi-Phase M)
(Fuji, PACSAT)

Sat-RX-2 435.155 MHz +/-10 kHz (AFC) 2400bps/BPSK/B-Phase S

Sat-RX-3a 435.193 MHz +/-10 kHz (AFC) 4800bps/RSM/NZRIC (Bi-Phase M)

Sat-RX-3b 435.193 MHz +/-10 kHz (AFC) 9600bps/RSM/NZRI (NRZ-S) + Scrambler

Sat-RX-4 435 193 MHz +/-10 kHz (Dig-AFC) Receiver for the RTX-DSP experiments

BEACON DOWNLINK = 145.983 MHz

Beacon 1:	1200bps/BPSK/NRZI (NRZ-S)	(like Fuji-OSCAR 12)
Beacon 2:	400bps/BPSK/Bi-Phase S	(AMSAT mode - like AMSAT-OSCAR 13)
Beacon 3:	2400bps/BPSK/Bi-Phase S	(like AMSAT-OSCAR 13's RUDAK beacon)
Beacon 4:	4800bps/BPSK/NRZIC (Bi-Phase M) (like 4800bps uplink)	
Beacon 5:	9600bps/RSM/NRZI (NRZ-S) + scrambler (like 9600bps uplink)	
Beacon 6:	CW	
Beacon 7:	FSK (F1 or F2B ?) e.g., RTTY, SSTV, FAX	
Beacon 8:	FM modulation with D/A for signals with DSP-RISC processors (e.g., Speech)	

Mass: 6.2 kg
Dimensions: 230 x 320 x 120 cubic mm

— *Eric Rosenberg, WA6YBT*

Entrepreneurs in Space?

Dear Joe: I enjoyed *A Beginner's Guide to OSCAR-13,* by Keith Berglund and AMSAT. It tells how to make and use your own station to talk through the OSCAR satellite. It hardly mentions people who will spend your money and design your station for you. Good. You wouldn't trust anyone that far with your own money. Space is new. So it would be easier for them to look important by recommending something to impress average people, than

by recommending something cost effective. Instead, the book tells about each of the main parts of the station. It lists some manufacturers that can sell each part now. It doesn't try to tell you how they could be made better. It compares specifications from each manufacturer, even the most important specification, the price.

I would like to see another book like that for businessmen thinking about having their own launchers. If there already is such a book, they should advertise it more. When you read up on space, the first information you find is about NASA and science fiction. The next easiest information to find is on projects engineered in detail by people who are wondering why someone hasn't sent them a blank check yet. I mean a book on launchers like the book on OSCAR-13. It would list and compare engines and other parts that you can really buy. Any manufacturer who won't quote a price probably isn't real interested in selling to anyone who's spending his own money. That may include all manufacturers, but change has to start somewhere.

If the book includes completed launcher proposals, exclude anyone who obviously can't put himself in the investor's shoes, or you'll lose credibility for everyone else. At least exclude manned or lunar proposals, as long as the market for a simple cost effective launcher is as wide open as it was decades ago when they convinced Congress that the $pace $huttle was the answer.

There are other parts of a project besides hardware, especially less noticeable parts like getting the money. But an Amateur group wouldn't know how. See *Astrobusiness* from Walden Book Co. and any book on venture capital. I think most of the engineers should come from Silicon Valley instead of NASA because I think it would be easier to retrain a computer engineer for space than to retrain an aerospace engineer for bottom line results.

Better yet, throw this away and ask a successful hi-tech entrepreneur. There aren't any in the space business, because an entrepreneur is someone who rewards his investors without getting into bed with NASA or with tax dollars. So that probably means asking a computer honcho like Bill Gates, or somebody that isn't so busy.

— Art LaPella

G3RUH Modem

(Continued from page 8)

Parts Sources:

AMSAT-UK accepts Mastercard & VISA; 94 Herongate Road, Wanstead Park, London E12 5EQ, England

RadioKIT accepts Mastercard & VISA; P.O. Box 973, Pelham, NH 03076, Phone: (603) 437-2722

Dick Smith Electronics accepts Mastercard & VISA; P. O. Box 468, Greenwood, IN 46142, Phone: (317) 888-7265

Active Electronics accepts Mastercard & VISA; P. O. Box 9100, (Stores in Westborough & Woburn, MA), Westborough, MA 01581; Long Island (NY), Mt. Laurel Phone: (800) ACTIVE-6(NJ), Detroit, Seattle, Santa Clara (CA) and others to open

TAPR accepts Mastercard & VISA; P. O. Box 12925, Tucson, AZ 85732, Phone: (602) 323-1710

Project OSCAR, Inc. Please include an SASE, P. O.Box 1136, Los Altos, CA 94023-1136

LAN-LINK is available from Joe Kasser, P.O. Box 3419, Silver Spring, MD 20918, Phone: (301) 593-6136

AMSAT News

(Continued from page 6)

W5UN and/or NK6K reset the DOVE CPU and turned the two meter transmitter off on March 17. Dave Blaschke, W5UN, is the owner of the world's largest privately owned two meter antenna. With 32.5 dBi gain, and nearly 2 megawatts of EIRP, he transmitted the reset sequence for several days. The batteries began flattening out and AMSAT-NA was alerted by Alberto Zagni, I2KBD, that the transmitter power was dropping significantly at the end of the eclipse. Alerted to this fact, N4HY had a planning session with W5UN as to the two best times to reset the spacecraft CPU and turn the transmitter off. The first was at the end of the eclipse period, when transmitter power would be at its lowest point. If it turned out that the battery voltage was too low to maintain the GaAsFET preamp in the receiver, then the next time to try was just as the transmitter power was falling off (soon after it left the sun and started the voltage descent in eclipse). The latter was the time which turned out to be successful. Almost immediately following the reset, NK6K sent charging rate commands and transmitter state commands. On March 18, N4HY sent the S band transmitter ON command. It immediately came on and KØRZ relayed acked packets, etc. to N4HY over the phone. For the present, DOVE will stay silent on 145.825 MHz, telemetry may be copied on the S Band beacon.

Reid Bristor, WA4UPD, Appointed as Technical Coordinator for Satellite Data Archiving.

Reid has set up a database using DEC computers and large, removable fixed disk drive systems and is now ready to begin receiving data for collating and storage. MicroSat files collected in either KISS or ASCII mode are acceptable. File naming is not yet standardized so any convention is valid as long as submitters include a note explaining how their personal naming convention works. A standard format for file naming and file contents will be published soon after which all submissions must conform.

At this time, all MicroSat datafiles are welcome.

This archive will be used to keep records on the MicroSat spacecraft over short and long term periods and to allow various

(Continued on page 29)

Six for the Price of One, or OSCAR Count Reaches 19

By the AMSAT team.

On 22 January 1990 OSCARs 14, 15, 16, 17, 18 and 19 were placed into orbit from an Ariane launch vehicle. We continue the diary of those hectic days before and after the launch. Part I appeared in the March, 1990 issue.

January 10, 1990 Continues

Junior battery charged through the night until 6:00 A.M. this morning when I came on-line. I will charge until the last minute. The SPOT people will start around 11:00 A.M. today. We will only be able to observe the replacement operation of the tape recorder from the monitor in our office in the S3C Building. We have worked very hard to put the maximum charge into the batteries because we don't know how long this operation will take. Max will be going to a meeting at 9:00 A.M. today and will let us know the status of the estimated start time of the tape recorder replacement. There will be no official launch date announcement from Arianespace until after the tape recorder is replaced. — *Dave, WDØHHU*

January 10, 1990 Tape Recorder Removed

The bad tape recorder has been removed from SPOT-2 and the new one will be here tonight. The SPOT people will test and trouble shoot the old one to see if this is a generic design problem or a one time occurrence. The technicians were very careful and there were no dropped tools. Tomorrow they will finish the replacement and then they will perform functional testing. Once they have declared that the new tape recorder is working properly, ARIANESPACE will make an announcement. Incidentally, it was not necessary to remove the 12 GHz antenna on SPOT-2 perhaps this will mean that we will launch sooner than January 26, 1990.

January 12, 1990 Launch Date Set and Status

Arianespace announced today that the launch of V35 is now set for January 21, 1990 at 01:35 UTC. The composite will be moved to the launcher on Monday, January 15th. Arianespace is making special provisions for MicroSats so that we don't have to go through another 21.5 hours without battery charging like the last time. The most we will be off is about 12-14 hours. After we reconnect at the block house, we will charge for 16 hours.

The replacement tape recorder for SPOT-2 was installed yesterday and the SPOT people were pleased with the functional testing. More importantly, *nothing* was dropped on the MicroSats or the UoSATs during this critical repair operation. The work on SPOT has now finished, and we have removed the protection from our satellites again.

January 15, 1990 Transfer to Launcher

The fairing has now been moved to the launcher and mounted atop the launcher. It looks like the total time without battery charging will be about 16 hours. We will charge for at least 16 hours. We will have a meeting today at 3:45 P.M. Kourou. Tomorrow Junior, Max, and I will be allowed to go up to the top of the gantry for a photo session with the MicroSat, UoSAT, & SPOT-2 logos affixed to the fairing. For the first time in 10 days we have finally seen the sun. Somehow we feel a sense of deja vu. — *Dave, WDØHHU, Junior, PY2BJO, and Max, G7DQE*

January 18, 1990 Status Report

Last night the AMSAT, UoSAT, and BRAMSAT teams went through a complete launch rehearsal so that we could check all communication lines and so that we would know what to expect. During the rehearsal we had a simulated problem, the count was held, but we launched on time moments before the window closed! How is that for realism. We were also given a complete set of orbital elements and amazingly, they were exactly *nominal*. Imagine that.

We are now charging the batteries on the MicroSats and UoSATs twelve hours a day. All the MicroSat batteries are around 11 volts after the end of day and when we come in the morning, the voltages have fallen to about 10 volts for each of the MicroSats. The UoSATs fly cold and their batteries are in excellent condition.

Events are moving quite quickly here. People are arriving, launch computers are constantly running tests on the launcher, and the pace has certainly picked up here. I liken the situation to a freight train starting up and hitting maximum speed around the morning of launch. So far the weather does not appear to be a problem. The weather constraints for launch are the following:

1 No lighting in the immediate area.

2 To move the gantry back, the wind speed has to be less than 38 mph.

3 For launch, the wind speed limits can be between 20 mph and 31 mph, depending on the direction. The high limit (31 mph) is the restriction if the wind is blowing out of the south; the lower limit (20 mph) is the limit if the wind is coming from the north. We are not exactly sure of why this is the case and we will investigate this and report back later.

4 Horizontal visibility has to be 600 meters or about 0.4 miles.

5 The cloud ceiling higher than 250 meters or about 820 ft. This constraint is because the Range Safety people have to be able to see the launcher immediately after launch and before the radars can start to track. — *Dave, WDØHHU, Junior, PY2BJO and Max, G7DQE*

January 20, 1990 Launch Status at 11:45 UTC

According to Arianespace officials, everything is moving along very well. Last night there was a problem fueling the first stage with UDMH but that problem was resolved. Right now I am charging the MicroSat and UoSat batteries. At 15:30 UTC I will shut off the battery chargers and go to the press conference. After the press conference I will come back and charge until 22:00 UTC. The weather looks good outside at the present time, but the weather is so changeable here. Two nights ago it was raining extremely hard at launch time. Last night we could have launched.

The next major milestone we have to get passed is the fueling of the third stage. That is an extremely delicate and difficult operation. That will happen at about T-6 hours. — *Dave, WDØHHU*

January 20, 1990 Launch Status at 15:30 UTC

Operations personnel here in the block house say that everything is proceeding well at this point in the launch chronology. Also they say that the weather people say that the forecast looks good for this evening. Right now I can see sunshine but there are quite a few clouds in the sky. Jean Grau, F8ZS, Inspector General of CNES, came by to pay a visit. Jean said that the French ham radio satellite should be ready to fly by 1992. So I am off to the press conference now and I will report back later. — *Dave, WDØHHU*

January 20, 1990 Launch Status at 18:30 UTC

The weather has deteriorated a little here. There are clouds almost all around the launcher and the wind is blowing at about 11 meters/second. But the launcher is still ready to go and the current weather conditions would not stop us from launching. They will start to move the gantry away in about 15 minutes at 18:45 UTC. I will be allowed to go out and take pictures. — *Dave, WDØHHU*

January 20, 1990 Launch Status at 19:10 UTC

They have just rolled the gantry back and talk about a skinny rocket! There are no strap on boosters. But the weather is holding and things are really rolling here. Guys are marking off milestones on blue print-looking bar charts. I will charge until 20:30 UTC as I need to be at the mission control room at 20:30 UTC. Folks, this is really exciting!!!

Every thing is still a go for launch. — *Dave, WDØHHU*

January 20, 1990 Launch Status at 20:47 UTC

I was taken out to within 0.5 km of the launcher and I was able to take plenty of pictures. One thing I can say is that our MicroSat logo really stood out in the crowd!

I have shut down the battery chargers.The following are the voltages and currents at 2030 UTC:

PACSAT	10.90 V	140 mA
DOVE	10.80 V	145 mA
WEBER	10.95 V	150 mA
LUSAT	10.89 V	130 mA

The weather is very strange right now. It is cloudy and extremely humid outside. But so far there are no constraints to launch. According to the launch chronology we start third stage fueling at T-04 hrs 5 minutes from launch. The show of security is very evident here right now. Lots of armed soldiers with automatic weapons running around outside right now. — *Dave, WDØHHU*

January 20, 1990 Launch Status at 21:38 GMT

The fueling of the third stage has begun at T-4 hrs 5 minutes which was two minutes ago. It was raining a short time ago but it has stopped now. They just gave a weather forecast and said that it is still good for a launch and was certainly good enough to fuel the third stage.

So I will go to dinner in a short while and then it is off to Jupiter Mission Control Room. — *Dave, WDØHHU*

January 21, 1990 Anniversary?

I guess I'm getting old, but our first launch as an organization occurred almost exactly 20 years ago, on January 23, 1970, when Australis-OSCAR-5 went up. I still have the tape of the telephone "ALINS" with W3GEY and W3ZM. Would it be stretching things too much to call this our 20th anniversary ALINS? 73 and good luck to all. — *Ray, W2RS*

January 21, 1990 Microsat Launch Scrubbed

V35 was scrubbed Saturday night due to bad weather, but they'll try again tomorrow — same time, 2035-45 Kourou time. — *Dave, WDØHHU*

January 21, 1990 Second Attempt! 11:39 UTC

This morning when I came into the blockhouse I saw that they have rolled the gantry back to enclose the launcher. As far as weather goes this morning, there was a light rain but I saw patches of blue and it was evident there was a high ceiling of clouds above. I will get a status report on the rocket and other important details in about two hours. We will pick up the launch countdown at T-12 hours. — *Dave, WDØHHU*

January 21, 1990 Second Attempt! 16:45 UTC

The countdown was picked up at T-12 hours and everything is proceeding well. So far everything is on schedule and there

are no problems. At the present time there are isolated rain showers around the area but you can see spots of blue sky when there are breaks in the sky. A high altitude ceiling of clouds exists above. Once again things are really picking up here in the block house. In a few minutes Maarten Merman from UoSAT will head out with Junior to the Jupiter Mission Control Room. There must be one representative from us at T-7 hours until launch. I will get there right after I finish dinner and make sure there are no problems with the launcher.

When Junior and Maarten came in, I just had to go back to the hotel and get some sleep. I was really worn out!! Also, last night I had a tire blow out on me on the way back to the hotel and I had to change a tire in the rain! Then I hit a bat! Yes a real flying thing. Imagine that. All sorts of things are possible in French Guiana. — *Dave, WDØHHU*

January 21, 1990 Second Attempt! 19:10 UTC

They have started to move the gantry back now things are on schedule. There are a lot of clouds around but nothing like yesterday. There are clouds at all different ceilings. In a little while I will switch off the battery charging equipment and shortly thereafter go to dinner. I will step outside and make an eyeball assessment of the weather. It doesn't look as bad today as it did yesterday. The countdown clock is ticking and I can see the gantry move right now on the TV monitor. Lets hope for good weather this time. I want everyone to think about good weather in Fr. Guiana. I know that will work. Maybe Tom Clark can talk directly with someone about that! — *Dave, WDØHHU*

January 21, 1990 Second Attempt! 21:35 UTC

The fueling of the third stage has started and that is proceeding well. The countdown clock is ticking away and things are once again getting busy here right now. Now for the weather. It looks a hell of lot better tonight at this point than it did last night. High altitude clouds with some lower ceiling clouds around. From the TV monitor in the blockhouse it doesn't appear to be raining. But it is not just pure rain that will stop a launch. It is big thunderstorms that will do it. I can see the sun in a few places and it would almost be a nice sunset. But we still have to consider that this is the rainy season for Fr. Guiana. I talked with one of the Arianespace payload managers and he says that for launches with such small windows, they may schedule them for the summer when the weather is not such a problem.

The battery chargers were switched off about an hour ago and here are the values:

PACSAT	10.87 V	140 mA
DOVE	10.82 V	135 mA
WEBER	10.87 V	160 mA
LUSAT	10.87 V	120 mA

— *Dave, WDØHHU*

January 22, 1990 Reflections on the Countdown

Listening to ALINS on 20 Meters, reception of W5RRR is pretty good. There is some QRM from a station who wants to know why we are using this frequency, and who else is interested in all that garbage about a launch. As the countdown reaches the last few seconds, my thoughts go back 10 years to May 23, 1980 when the first Phase-3 spacecraft was lost due to a launch vehicle malfunction[3]. AMSAT recovered from that ''black Friday'', and have since built and orbited two Phase-3 spacecraft (AMSAT-OSCARs-10 and 13). The countdown ends and it's up, up and away. I hear the ALINS relay the telephone link, and hear reports of spacecraft separation. W3GEY asks someone to verify that the green lights are illuminated on the board to verify separation. The verification is given, and Jan explains that those lights are connected to the vehicle telemetry showing the state of the separation switches. So far so good. Now that they are up, they change their names and acquire numbers in the order of separation, as follows:

Spacecraft: OSCAR number
UoSAT-D: UoSAT-OSCAR-14 or UO-14
UoSAT-E: UoSAT-OSCAR-15 or UO-15
PACSAT: AMSAT-OSCAR-16 (PACSAT) or PO-16
DOVE: DOVE-OSCAR-17 or DO-17
WEBERSAT: WEBER-OSCAR-18 or WO-18
LUSAT: LUSAT-OSCAR-19 or LO-19

LUSAT has become Argentina's first ever spacecraft, professional or amateur. In the days of AMSAT-OSCAR-6, the first space ground station in a number of countries was a Radio Amateur working through that spacecraft, sometimes not knowing if his 2M receiver was working, because there was no one out there to work[4]. Now, Amateurs have done it again and built (and launched) the first spacecraft from a country. — *Joe, W3/G3ZCZ*

January 22, 1990 MicroSat Progress

The UoSAT-14/15 modulation is NOT, repeat NOT AFSK. It is straight FSK. The digital 1/0 pattern directly shifts the

Consecutive frames from spacecraft during the final telemetry dump at Kourou. Harold Price, NK6K


```
DOVE-1>TIME-1:PHT: uptime is 004/20:40:46. Time is Tue Dec 19 11:09:40 1989

DOVE-1>TLM:00 58 01:5C 02:7E 03:29 04:40 05:5D 06.6A 07:3D 08:6D 09.5D 0A A6
0B B6 0C:E8 0D:DC 0E:04 0F:26 10:DC 11:86 12:00 13:0C 14:7C 15:7B
16:79 17:74 18:78 19:77 1A:78 1B:53 1C:7C 1D:76 1E:D0 1F:62 20:C6

DOVE-1>TLM.21:A8 22:76 23:10 24:0B 25:1E 26:00 27:00 28:00 29 00 2A:00 2B 01
2C:4C 2D:34 2E:3A 2F:7A 30 9B 31:7C 32:00 33:00 34:7D 35:7E 36:7D
37 7E 38 7D 39:7C 3A.01

DOVE-1>STATUS: 00 00 00 80 B0 18 55 00 00 B0 00 00 30 00 00 00 00 00 00 00

DOVE-1>WASH:wash addr 2500.0000, edac=0xaa
DOVE-1>TIME-1:PHT. uptime is 004/20:40:56. Time is Tue Dec 19 11:09:50 1989

DOVE-1>TLM:00:60 01 5B 02:7F 03.2A 04:3D 05:59 06:70 07:3D 08:6E 09:5E 0A A4
0B B6 0C E8 0D:DC 0E 05 0F:26 10.DC 11:86 12:00 13:0C 14:7C 15:7C
16:76 17:74 18.76 19.77 1A:74 1B.53 1C:7C 1D:76 1E:D0 1F:62 20:C5

DOVE-1>TLM.21.AA 22:75 23.10 24:0C 25:1E 26:00 27:00 28:00 29:00 2A:00 2B:00
2C 4B 2D.32 2E:3A 2F:7A 30 9A 31:7A 32 00 33:00 34:7C 35:7D 36:7E
37 7E 38 7D 39 7C 3A 01

DOVE-1>STATUS 00 00 00 80 B0 18 55 00 00 B0 00 00 30 00 00 00 00 00 00 00

DOVE-1>WASH wash addr 2740 0000, edac=0xaa

LUSAT-1>TIME-1 PHT uptime is 004/20:09:50. Time is Tue Dec 19 11:01.43 1989

LUSAT-1>TLM 00 62 01 72 02 6E 03.5F 04:70 05:7A 06 6A 07:85 08:6A 09:71 0A A5
0B 9D 0C E7 0D DD 0E 05 0F 51 10 DC 11 85 12 00 13 05 14:7D 15.7A
16 6E 17 6A 18 6D 19 70 1A 6A 1B 6B 1C:68 1D 65 1E CE 1F.5F 20 A2

LUSAT-1>TLM 21 90 22 78 23 02 24:00 25 15 26:00 27.02 28:00 29 01 2A 00 2B 01
2C 3E 2D 35 2E 2E 2F 7A 30 77 31.77 32 00 33 00 34 7D 35 7A 36 7A
37 7A 38 80 39 7A 3A 7A 3B FF 3C FF

LUSAT-1>STATUS: 00 00 00 80 B0 18 55 03 00 00 00 00 30 00 00 00 00 00 00 00

LUSAT-1>WASH.wash addr:0d40 0000, edac=0x0b
LUSAT-1>TIME-1:PHT: uptime is 004/20:10:00. Time is Tue Dec 19 11:01:53 1989

LUSAT-1>TLM 00.62 01:75 02:70 03.5F 04:67 05:7D 06:6D 07:85 08:6A 09 75 0A A5
0B.9F 0C.E7 0D:DD 0E:05 0F.50 10:DC 11:85 12:00 13:05 14:7D 15:7A
16:6D 17:70 18:6D 19:70 1A.6A 1B:6E 1C:65 1D 65 1E:CE 1F:5F 20 9D

LUSAT-1>TLM:21:90 22:78 23:02 24:01 25:15 26 00 27:02 28 00 29:01 2A:00 2B 00
2C 3E 2D:38 2E:2E 2F:7A 30.78 31:7A 32:00 33.01 34 80 35 7A 36 7A
37:7A 38 80 39:7A 3A 7A 3B:FF 3C:FF

LUSAT-1>STATUS: 00 00 00 80 B0 18 55 03 00 00 00 00 30 00 00 00 00 00 00 00

LUSAT-1>WASH:wash addr 0f80 0000, edac=0x0b

PACSAT-1>TIME-1 PHT uptime is 004/22 46:30. Time is Tue Dec 19 11 15 31
1989

PACSAT-1>TLM.00.6A 01.82 02:6E 03 64 04 69 05.8C 06 5D 07:62 08 70 09 80
0A A6
0B 98 0C E7 0D DC 0E.19 0F.30 10 E2 11:82 12 00 13 09 14 7C 15 7B
16 6F 17 5F 18.6F 19:6B 1A.70 1B 76 1C:6C 1D:6C 1E.CB 1F 5F 20 AA

PACSAT-1>TLM 21 8C 22 76 23 0C 24:08 25 1B 26 00 27 00 28 00 29 00 2A 00
2B 00
2C.4C 2D 34 2E 47 2F:79 30 78 31:78 32 00 33 00 34 7E 35 7E 36 7D
37 7D 38 7D 39 9D 3A 01

PACSAT-1>STATUS 00 00 00 80 B0 18 55 03 00 80 00 00 30 00 00 00 00 00 00
0 0

PACSAT-1>WASH wash addr 10c0 0000, edac=0xd8
PACSAT-1>TIME-1 PHT uptime is 004/22 46.40 Time is Tue Dec 19 11 15 41
1989

PACSAT-1>TLM 00 67 01 84 02 70 03 67 04 6B 05 90 06 5A 07 64 08 70 09 80
0A A5
0B 98 0C E7 0D DE 0E 1A 0F 31 10 E2 11 82 12 00 13 09 14 7C 15 7A
16 6D 17 70 18 5F 19 5F 1A 70 1B 73 1C 70 1D 68 1E CC 1F 5F 20 AA

PACSAT-1>TLM:21:8D 22:77 23:0D 24:08 25:1C 26.00 27:00 28 00 29:00 2A.01
2B 00
2C.4C 2D:34 2E:48 2F:78 30:7A 31:7A 32:00 33.00 34:7D 35:7F 36 7E
37:7D 38.7D 39:9C 3A:00

PACSAT-1>STATUS: 00 00 00 80 B0 18 55 03 00 80 00 00 30 00 00 00 00 00 00
0 0

PACSAT-1>WASH:wash addr:1300 0000, edac=0xd8

WEBER-1>TIME-1.PHT: uptime is 004/21:50:10. Time is Tue Dec 19 11.20.40 1989

WEBER-1>TLM.00 74 01:6F 02.69 03.7B 04:70 05:8C 06:71 07:7F 08:6B 09 31 0A 8C
0B 9E 0C:BD 0D:A4 0E:06 0F:59 10:92 11:81 12:04 13:51 14:7C 15:7A
16:76 17:70 18:6B 19 74 1A:6B 1B:75 1C:6E 1D:75 1E:C8 1F:65 20:9C

WEBER-1>TLM 21:91 22:77 23:11 24.12 25.22 26 00 27:00 28.00 29:00 2A 00 2B 00
2C 60 2D:43 2E:51 2F:79 30:78 31.79 32:28 33:28 34 7C 35:7C 36 7C
37:7C 38:BE 39 F6 3A:79 3B:94 3C:EF 3D:FF 3E:42 3F:BF 40:7D 41:7D
42:BF

WEBER-1>STATUS 00 00 00 80 B0 18 55 03 00 FB EF FF 30 00 00 00 00 00 00 00

WEBER-1>WASH wash addr:0c80 0000, edac=0x22
WEBER-1>TIME-1:PHT uptime is 004/21 50.20. Time is Tue Dec 19 11 20.50 1989

WEBER-1>TLM:00 74 01:6E 02.68 03:7B 04 70 05 8C 06 70 07:7D 08 68 09 2E 0A 8C
0B:9E 0C BD 0D:A4 0E:06 0F:5A 10:92 11 81 12:04 13 52 14.7C 15 7A
16:6D 17:6F 18:6C 19:74 1A:6A 1B 75 1C 6C 1D:75 1E C8 1F 64 20 9C

WEBER-1>TLM 21.91 22:76 23.12 24 12 25 21 26 00 27 00 28 00 29 00 2A 00 2B 00
2C 60 2D:43 2E.51 2F:7A 30 78 31 7A 32 28 33 26 34 7C 35 7C 36 7C
37:7C 38 BF 39.FD 3A 78 3B 94 3C DF 3D FF 3E 42 3F BF 40 7D 41 7C
42 BF

WEBER-1>STATUS 00 00 00 80 B0 18 55 03 00 FB EF FF 30 00 00 00 00 00 00 00

WEBER-1>WASH wash addr 0ec0 0000, edac=0x22
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transmitter frequency and no audio is involved. — *Doug, KO5I*

Looks like WEBERSAT survived the launch. In the brief 3 degree elevation pass I was able to copy a few frames after Harold kicked it. I find it amazing to note that the time-of-day clock was within a few seconds given it was set 38 days ago!

I observed some fairly deep fades here — fading rate seemed to be about 30 seconds. The fades played havoc with my trying to keep in lock! — *Tom, W3IWI*

The LUSAT PSK beacon was commanded on by NK6K @W6TRW at around 5:13 UTC. — *Harold, NK6K*

I couldn't copy the LUSAT telemetry but Harold got it on. Chris Williams and the folks at Weber State successfully commanded WEBER on. They could not copy frames (had trouble tuning the PSK in, sound familiar to your first time?).

Can't wait to take another stab at DOVE in the morning, if it hasn't turned itself on automagically to keep from overcharging the batteries. — *Bob, N4HY*

It would appear that we got PACSAT turned on manually at the end of the 2nd Los Angeles pass, making WEBER, LUSAT, and PACSAT all turned on by command. We were sending DOVE ON commands on the third pass, but it may be that the software turned it on after the second pass. As we accumulate data from the field, we'll know more.

In any case, all are on, and on the TX1 (straight PSK) frequencies. The signals were bodacious on the third pass as the software had cranked up the power during the lighted portion of the second pass, to about 3 Watts on each spacecraft.

The TRW crew did an excellent job of setting up the station on the west coast. — *Harold, NK6K*

The algorithms turned on the remainder of the satellites when the battery voltage was above the trip level.

Both DOVE and PACSAT came on. All birds are alive and well!!!!!!!!! — *Bob, N4HY*

The UoSAT-OSCARs-14 and 15 were both successfully commanded ON by the UoSAT Control station in Guildford this morning. On the 0900 UTC pass, the 435.120 MHz transmitter on UoSAT-OSCAR-15 was enabled and the satellite started transmitting engineering telemetry. UoSAT-OSCAR-14 was first commanded on the 1030 UTC pass. Further telemetry was received on the 1200 UTC pass. The downlinks are running at 50% duty cycle, currently 1 minute on and 1 minute off; this may be changed to 10 minutes on 10 minutes off during the 1400 UTC pass.

During the first days of operation, the two satellites will transmit several different data formats. These will all be asynchronous bytes sent at 1200 bits/second, using AFSK-FM modulation. The data can be demodulated by any UoSAT-OSCAR-9/11 decoder connected to a 435 MHz FM receiver. Unlike UoSAT-OSCAR-11, which uses ASCII characters for most of its data formats, much of the demodulated data from the new satellites BINARY, and not printable ASCII. This data will be coming from one of two onboard sources: the dedicated hardware telemetry system, or the 1802 onboard computer operating system (known as the DIARY).

The dedicated hardware telemetry system is built around a custom-designed Very-Large-Scale Integrated Circuit (VLSI) manufactured especially for these satellites. This telemetry system is independent of all onboard computers, and provides UoSAT engineers with a simple way to monitor the health of the satellite. Telemetry is transmitted by the VLSI system in 10-byte "packets", each beginning with the bytes FF FF (hexadecimal). The VLSI system should only be in use for a few more orbits, so we will not publish the packet format at this time; if it is used for longer than expected, more detailed information will be distributed.

As soon as possible, we will load the FORTH operating system — DIARY — to

the primary onboard computers on the satellites. The DIARY will allow us to begin more complex operations, such as whole-orbit-data collections, initial attitude determination, and deployment of the gravity-gradient boom. When the FORTH DIARY has been loaded, printable ASCII data (including a news bulletin) will be mixed with binary data formats.

Anyone who can get a BINARY logs of data from UoSAT-3 (OSCAR-14) or UoSAT-4 (OSCAR-15) on IBM disks is encouraged to send them to the UoSAT Team, The University of Surrey, Guildford, SURREY, GU2 5XH, United Kingdom. Further information, including descriptions of the DIARY data formats, will follow. — *Jeff, GØ/K8KA*

January 22, 1990 After Launch Elements

These MicroSat elements are derived from numbers provided by Arianespace.

Epoch:	22JAN90 015207
Incli:	98.73
RAAN:	97.9558
Ecce:	0.0013
ARGP:	93.9
Mean Anom:	302.31
Mean Mot:	14.2547138
Drag.:	0.000005
Apogee:	816.0km
Perigee:	798.1km

— *Bob, N4HY*

(* *Editor's note: DO NOT USE these elements, use those on the regular element page.)*

January 22, 1990 Kourou Reporting

Junior is a very happy man because we heard DOVE with a HT and he said it was very strong at an 8 degree elevation!!! Junior leaves Kourou tonight and I hope to leave Wednesday! I will start to pack a few things then I will go to Devil's Island tomorrow. — *Dave, WDØHHU*

January 22, 1990 Command Station Reports

I commanded PACSAT over to the Raised Cosine Transmitter. It is our plan to leave it there. As soon as I can get WEBER swapped over, I will swap it as well. This will make these birds much easier to tune. Harold will be uploading new code to WEBER today. I *urge* folks not to transmit anything as this will interfere with the process. The bird will not acknowledge you (and if it does, there is a bug and you might damage things). One of the things we will be changing is the power control algorithm which is underdamped. This should make the birds much easier to copy all around the orbit. Until we get the code uploaded, the nighttime passes should be spectacularly loud since they will have just come out of the sun and will be at MAX power.

The frequency for AO-16 (PACSAT) now is 437.050 MHz +/- Doppler.

If we get WEBER changed, it will be 437.100 MHz.

On the RC transmitters: They use socially acceptable PSK and will make modems easier to tune. Run a standard terminal program to make sure that your TNC is decoding the stuff and this will help with tuning. This will also enable you to grow accustomed to tuning again. I can't believe how much trouble I had in Boulder even though I was one of the really active folks on Fuji-OSCAR-12. Even now, I am having trouble tuning in WEBER even though the rest of them are easy. It will all get easier for us with time. — *Bob, N4HY*

All six are on and sounding beautiful here during Rev. 8. AOS and LOS both about 2 minutes early using N4HY's element set derived from Arianespace.

During Rev. 9, I decided to try for a good set of AOS/LOS/TCA times on one satellite, rather than jumping around after six of them like the proverbial one-armed paper hanger. Since my downlink system is better on 2M than on 70cm, I settled on DOVE.

According to N4HY's *unmodified* set of Keplerians (with epoch of 01:52:07), scheduled AOS for me was 15:42:00, scheduled TCA was 14:49:30 and scheduled LOS was 15:57:00, all with SATSCAN 2 set for 30-second readouts at my QTH of 40 56 47 N, 74 07 29 W.

I did not get a clean AOS time because the satellite came up in its 30-second OFF period, switching on at 15:40:18. Judging by the signal strength when it came on and the fact that I did not hear it when it switched off at 15:39:48, I would estimate AOS to be 15:40:00 +/- 5 sec. or so. I got a clean LOS at 15:55:35. From the Doppler curve, TCA occurred between 15:47:30 and 15:48:00.

Thus, AOS was 2 minutes early, LOS was 1 1/2 minutes early and TCA was approximately 1 3/4 minutes early. Averaging these readings, I come out with the finding that DOVE was 1 minute 45 seconds early during Rev. 9.

Observations here of DOVE on Rev. 10 were as follows, all referenced to Bob's *unmodified* element set:

AOS 17:20:17 (2 min 30 sec early)
TCA 17:26:40 (1 min 55 sec early)
LOS 17:33:10 (1 min 20 sec early)

Averaging these readings, I conclude that DOVE was 1 min 55 sec early on Rev. 10, compared with 1 min 45 sec early on Rev. 9.

Although we do not have readings for DOVE from last night, LUSAT was right on time during Rev. 1 at a number of locations and it is doubtful that the birds would have drifted apart that far in so short a time. My tentative conclusion is that the early readings are progressive rather than constant, i.e., that the parameter to change is probably the mean motion rather than the epoch time. If we use Bob's original epoch time of 01:52:07 and a mean motion of 14.28492 rather than the original value of 14.2547138, we get a set of elements that fits within a couple of seconds. Let's see what we get from subsequent observations. — *Ray, W2RS*

January 23, 1990 More Commanding

WEBER is using the raised Cosine transmitter and will be switching on their experiment package during the next orbit (visible in UTAH). I will be attempting to command DOVE. I am nearly *desperate* for a *decent* set of elements. These are pretty bad. — *Bob, N4HY*

January 23, 1990 Observations, Rev. 14

Radio observations taken of DOVE during Rev. 14 averaged 3 min. 10 sec. early compared with Bob's unmodified element set derived last night from Arianespace info. My suggested modification following Rev. 10 this morning, that we leave the epoch time alone at 22 days 1 hour 52 min 7 sec but change the mean motion to 14.28492, came out within 5 seconds of my Rev. 14 observation. To fine-tune it a little more, I suggest that we use 14.28575; that should get it right on. — *Ray, W2RS*

January 23, 1990 EDAC Errors

Based on the prelaunch value of the EDAC error counter, we have already experienced a few single event upsets (SEUs) on each of the MicroSats. This is normal and to be expected. The counter for LUSAT shows many errors, this is more likely to have been a single correctable error in executable code rather than many individual SEUs.

Each time that the hardware reads a byte containing a bit which was corrupted by a high energy particle, the correction process ticks into the EDAC error counter. If the bad byte is read, corrected by hardware, then rewritten by the program, it will not be corrected the next time it is read. The "wash" routine goes through each of the 256k of hardware protected bytes, reading and rewriting all of memory each 4.3 minutes. As a bad byte is read, it is corrected, counted, and rewritten/fixed. This gets one count per error.

Examples of early mission telemetry copied by JR1ING in Tokyo.

PACSAT TELEM. #6 437.025MHz PSK by JR1ING
PACSAT-1>TIME-1:PHT: uptime is 038/23:22:20. Time is Mon Jan 22 11:51:21 1990

PACSAT-1>TLM:00:C2 01:97 02:D2 03:7A 04:EA 05:9F 06:F8 07:73 08:6C 09:90 0A:A4
0B:99 0C:E7 0D:DB 0E:00 0F:32 10:D2 11:81 12:00 13:02 14:A6 15:94
16:8D 17:8E 18:8B 19:88 1A:8B 1B:84 1C:8E 1D:90 1E:24 1F:5C 20:97

PACSAT-1>WASH:wash addr:1640:0000, edac=0xd9

PACSAT-1>STATUS: 00 00 00 7F B0 18 DD 02 00 80 00 00 B0 00 00 00 00 00 00 00

PACSAT-1>TLM:21:6F 22:71 23:57 24:44 25:24 26:01 27:00 28:00 29:00 2A:00 2B.01
2C:00 2D:27 2E:00 2F:97 30:96 31:98 32:B0 33:01 34:9E 35:9D 36:BC
37:91 38:B0 39:CA 3A:00

LUSAT TELEM. #6 437.150MHz by JR1ING
LUSAT-1>TIME-1:PHT: uptime is 038/21:01:10. Time is Mon Jan 22 11:53:03 1990

LUSAT-1>TLM:00:E7 01:7D 02:D8 03:67 04:DD 05:8A 06:4D 07:8D 08:67 09:7D 0A:A4
0B:9D 0C:E5 0D:D7 0E:00 0F:49 10:CA 11:85 12:01 13:01 14:A5 15:95
16:90 17:8A 18:85 19:8A 1A:85 1B:7D 1C:7F 1D:85 1E:22 1F:5A 20:80

LUSAT-1>TLM:21:71 22:72 23:5C 24:45 25:2A 26:00 27:01 28:00 29:00 2A:01 2B:00
2C:00 2D:38 2E:01 2F:98 30:98 31:97 32:A9 33:00 34:9A 35:9D 36:BC
37:98 38:B4 39:9D 3A:9C 3B:FF 3C:02

LUSAT-1>STATUS: 00 00 00 82 B0 18 CC 02 00 00 00 00 B0 00 00 00 00 00 00 00

LUSAT-1>WASH:wash addr:2240:0000, edac=0x0c
LUSAT-1>TIME-1:PHT: uptime is 038/21:01:20. Time is Mon Jan 22 11:53:13 1990

DOVE TELEM. #6 145.825MHz FSK (bell202) by JR1ING
DOVE-1>TIME-1:PHT: uptime is 038/21:28:17. Time is Mon Jan 22 11:57:11 1990

DOVE-1>TLM:00:58 01:58 02:86 03:32 04:58 05:58 06:6D 07:42 08:6C 09:63 0A:A2
0B:DC 0C:E8 0D:D8 0E:00 0F:24 10:CD 11:B5 12:00 13:02 14:AA 15:98
16:98 17:92 18:94 19:94 1A:91 1B:87 1C:98 1D:98 1E:23 1F:5E 20:BC

DOVE-1>TLM:21:98 22:76 23:2E 24:28 25:2E 26:00 27:00 28:00 29:00 2A:00 2B:00
2C:00 2D:29 2E:00 2F:98 30:C4 31:98 32:E4 33:11 34:BD 35:97 36:9F
37:8E 38:B4 39:96 3A:00

DOVE-1>STATUS: 00 00 00 82 B0 18 EE 01 00 B0 00 00 B0 00 00 00 00 00 00 00

DOVE-1>WASH:wash addr:0440:0000, edac=0xab
DOVE-1>TIME-1:PHT: uptime is 038/21:28:27. Time is Mon Jan 22 11:57:21 1990

WEBERSAT TELEM. #6 435.075MHz PSK by JR1ING
WEBER-1>TLM:00:50 01:7D 02:64 03:8B 04:71 05:9A 06:59 07:8E 08:45 09:46 0A:A2
0B:A5 0C:CC 0D:B9 0E:08 0F:70 10:AC 11:8D 12:06 13:68 14:A4 15:9E
16:86 17:83 18:80 19:87 1A:80 1B:7F 1C:81 1D:8C 1E:28 1F:60 20:9A

WEBER-1>STATUS: 00 00 00 7E B0 18 99 02 00 FB EF FF B0 00 00 00 00 00 00 00

WEBER-1>TIME-1:PHT: uptime is 038/22:28:20. Time is Mon Jan 22 11:58:50 1990

WEBER-1>STATUS: 00 00 00 7E B0 18 99 02 00 FB EF FF B0 00 00 00 00 00 00 00

WEBER-1>WASH:wash addr:0840:0000, edac=0x25
WEBER-1>TIME-1:PHT: uptime is 038/22:28:40. Time is Mon Jan 22 11:59:10 1990

WEBER-1>BCRXMT:vbat= 10.675 vlo1= 10.623 vlo2= 10.123 vmax= 11.623 temp= 3.200

WEBER-1>WASH:wash addr:0a80:0000, edac=0x25

If the error is in a part of the program or data that is read by a process other than the wash program, an error will occur each time it is read, until it is fixed by the wash. This results in several counts per error rather than just one. I suspect that is what happened to LUSAT. — *Harold, NK6K*

January 23, 1990 Other items

The IR sensors are in their most sensitive setting (the default). We'll probably crank in the log scale in the next few passes. However, there already can be a case made for seeing the sun and the Earth, when the +Z face (with the IR sensor) is getting current, the IR is 255 counts, when -Z is getting sun and +Z is not, the count is in the 21 through 146 range. As this data was taken near local noon, chances are good the +Z was Earth pointing (if -Z was sun pointing). When both Zs are dark, the IR is 0. — *Harold, NK6K*

January 23, 1990 Status Report

For those of you interested in doing some experimental work, I have switched the IR sensors on PACSAT and LUSAT to the logarithmic scale. I will switch the sensors to the logarithmic scale on DOVE during the night. It will be interesting to gather some data on the illumination of the panels so that we can begin to determine a spin model. Harold has already begun to collect the data (see! Mushroom/Hackers can do science) and is the impetus for the IR sensor change. Start using all these volumes of data to learn something while we work out our little problems and get some software loaded. Harold is working on a load for WEBER and I am working on a load for DOVE. Harold will begin testing the new loader after his upload attempts tonight, away we will go! — *Bob, N4HY*

January 24, 1990 Flight Software Status

We have begun checking the pulse of the software loader on several of the spacecraft in anticipation of the first software uploads. Tonight we tried the S band transmitter and that will be reported elsewhere.

All the spacecraft battery charge/power control algorithms were seeded with values at just the right time, with the single exception of LUSAT, which I will return to in a moment. I took a *swag* at the right values to put in and DOVE, WEBER, and PACSAT have their power control algorithms locked. We do not wish to have to do this regularly so the next upload will have a better damped control algorithm for the power/battery charging.

I am sure that many of you have copied the LUSAT CW beacon and it was the first signal we heard from the spacecraft after launch. The only problem with LUSAT is that its power algorithm has not settled into a steady state.

In the morning (1444 UTC 1/24/90) I will turn OFF the LUSAT PSK transmitters if the power algorithm has not stabilized in order to get a good charge on the batteries. I have a value I want to seed to the transmitter power control but it will take a good charge on the batteries. I propose that I leave them off no longer than 12-16 hours tomorrow (daylight over US) and tomorrow night I will seed the power control algorithm and see if we can bring the power loop into lock. I believe that the automatic battery overcharge algorithm will trip long before then after we have a good charge on the batteries. You will still be able to copy LUSAT CW telemetry through the day. — *Bob, N4HY*

January 24, 1990 Experiments' Channel Assignments

Things have been hectic since launch. I have a few spare moments and I thought people might be interested in hearing about what sort of things have been going on.

First, as most know, we commanded WEBERSAT's BPSK XMTR on Sunday night. We could not lock our modem to copy telemetry during that pass because

1) it isn't real easy to do the first time one must in a Dopplered environment and

2) the initial element set had some error and our antennas seemed always to be on the fringe of the beamwidth which made for a noisy signal. Our thanks to W3IWI and the others who were kind enough to send us the telemetry frames they had copied from WEBERSAT that night. It was from those that we obtained our first glimpse of conditions aboard and were able to plan what to do on the next pass.

Since then, Bob, N4HY, commanded the RC TX on and the BPSK TX off. The RC TX seems somewhat easier to lock with a PSK modem, as he knew it would be. That, plus a modification from Bob and Ray, W2RS, to the mean motion element, has provided us with totally reliable telemetry monitoring from the spacecraft. We have also monitored telemetry from the other three MicroSats including Jose's endearing CW beacon on LUSAT.

We have been working hard since. We have commanded our experiment package on and off and collected data in both conditions. Within a few days, I expect to have some preliminary results for everyone. We expect to be able to provide a numeric definition of dark from our horizon sensors. All the values from all channels (non thermistor) do assume different values when they are on vs. when they are off. At first glance, that suggests all survived launch.

The temperatures in the "attic" are found on channels 40 and 41 of the telemetry. I have seen them as high as 6 degrees and as low as 1 degree. The same circuitry is used and the same thermistor as all other temps. so the same conversion formulas work.

The next few days, we will be concentrating on preparations for putting snapshot software aboard. Harold must load a new loader before we can start. I won't bother to give you a time estimate for how long it will take to get the loader aboard and then our routines. Don't expect it this week. Additionally, part of the load process will include the new control parameters for the TX power agility algorithm. You'll hear about all that stuff from Bob and Harold. — *Chris, WA3PSD*

January 24, 1990 Pacsat 2401 MHz Beacon

Bill, KØRZ, and myself, W3GEY, both watched PACSAT-1 on 2401.142 MHz for about 10 minutes on orbit 29 tonight. Max. elevation was 3.4 degrees at Boulder and signal strength peaked out at 10 dB over S-9! Total Doppler was more than 50 kHz. We still got 6 or 7 minutes of solid packets on S-Band. The pattern of the spacecraft

From: The American Radio Relay League
To: AMSAT
Subj: Microsats

ATTN: AMSAT President Loughmiller

Dear Doug:

Congratulations to AMSAT for the successful orbiting of four Microsats. What the AMSAT team has done reflects credit on the entire Amateur Radio community. The timing couldn't be better as we begin preparation for the World Administrative Radio Conference to be held in 1992. This achievement adds to others involving Hurricane Hugo and the Bay Area earthquake.

As an engineering project, it was nothing short of spectacular. By all conventional measures, the time from conception to deployment was inadequate, there was too much riding on a single string, and the project was underfinanced. AMSAT has once again pulled a rabbit out of the hat.

AMSAT can justifiably take pride in providing the Amateur Radio community with a new communications capability. The American Radio Relay League shares in your pride and is pleased to have had the opportunity of contributing to the project.

In confident anticipation of a successful launch, the ARRL Board of Directors passed the following resolution:

"The ARRL Board of Directors, on behalf of the officers and members proclaim for all to note that:

"Whereas the amateur satellite program represents a major source of technological advancement within the Amateur Radio Community and

"Whereas the amateur satellite program has a long history of providing useful communications resources to Radio Amateurs worldwide and

"Whereas the amateur satellite program is a major element of the public service, education, and scientific research being conducted via Amateur Radio today and

"Whereas the amateur satellite program represents the resourceful, creative, innovative, and volunteer spirit of Radio Amateurs everywhere and

"Whereas 1990 will see the launch of eight new OSCAR satellites including six on a single launch vehicle with the Microsat/UOSAT launch and

"Whereas 1990 will see the construction of an additional OSCAR satellite by AMSAT Italy and AMSAT North America begin and

"Whereas 1990 will mark the beginning of the Phase III-D construction activity by a broad base of international amateur participants

"Therefore be it resolved, that in recognition of the contribution of the amateur satellite program to the Amateur Radio service and of the significant events which are to occur during the course of the year 1990 within this discipline of Amateur Radio, we hereby declare:

"1990 the year of the Amateur Satellite Program."

73,

David Sumner, K1ZZ,
Executive Vice President, ARRL

An example of PACSAT Mode S Beacon Telemetry

```
PACSAT-1>BCRXMT
vbat= 10.540 vlo1= 10.518 vlo2= 10.018 vmax= 11.518 temp= 7.568

PACSAT-1>WASH
wash addr.19c0 0000, edac=0x7d

PACSAT-1>TIME-1
PHT: uptime is 040/14:10:00. Time is Wed Jan 24 02:39:01 1990

PACSAT-1>TLM
00 86 01.89 02:71 03:50 04:94 05:89 06:96 07:5F 08:6E 09:82 0A:A4
0B:96 0C:E7 0D:DC 0E:00 0F:31 10:D4 11:80 12:00 13:01 14:B0 15:9C
16 8D 17:8C 18:8C 19:85 1A:86 1B:7D 1C:88 1D:8B 1E:24 1F:5C 20:A1

PACSAT-1>TLM
21:75 22:77 23:48 24:3A 25:36 26:00 27:00 28:00 29:00 2A:00 2B:00
2C 00 2D:32 2E:00 2F:99 30:9A 31:9B 32:01 33:26 34:A4 35:9F 36:C5
37 A2 38 B9 39 BF 3A ED

PACSAT-1>STATUS
 80 00 00 85 B0 18 88 01 00 00 00 00 B0 00 00 00 00 00 00 00
```

antenna seems to be excellent. We had a lot more trouble on the high elevation pass on orbit 30. The elements are still off because we had AOS about 2 minutes early and LOS also two minutes early. This error is significant when you are using an antenna with about a 7 degree beamwidth.

70 cm carriers were all about 20 dB over S-9 and the 2M signal from DOVE was pegging Bill's meter!

I want to encourage interested microwave users to try this satellite because the signals are loud and the modulation is not that hard to receive with the available modems. A simple 10 to 20 turn helix will produce excellent results and promises to provide a very small antenna set-up. It's definitely fun! We didn't get a chance to see if the TAPR PSK modem would keep up with the Doppler shift because Bill hasn't complete his cabling for that function as yet. With Bill peaking the antennas and me keeping the frequency centered we got many minutes of solid copy. We'll be turning it on regularly soon.

A special thanks to Matjaz Vidmar, YT3MV, who built the two S-band transmitters last spring near the end of his stay in the United States. They work just great! Give them a try. — *Jan, W3GEY*

The equipment here is a 4 ft. grid dish and a feed mounted preamplifier of 0.8 dB NF. The feed is horizontally polarized. This is the same system used on AMSAT-OSCAR-13 Mode S. The dish is positioned automatically via computer.

On orbit 29 the S/C elevation was 3.4 degrees maximum. A sample of the telemetry received on 2401 MHz using a TAPR PSK modem and an AEA PK-88 TNC is shown in the sidebar. Total Doppler shift was 62 kHz. The 2401 MHz Beacon was shutdown midway through orbit 30. — *Bill, KØRZ*

January 24, 1990 UoSAT-OSCAR-14

The UoSAT-OSCAR-14 1802 On Board Computer is now running its FORTH operating system (DIARY). The DIARY — 17 kbytes of computer code — was uploaded on 22 January, during the 1845 UTC evening pass over Guildford. One of the important features of the DIARY is its ability to store telemetry data during one or more orbits and to relay this data to the groundstation. This technique was first used on UoSAT-OSCAR-9, and dubbed "Whole Orbit Data" or WOD. Three WOD surveys have been collected by the UoSAT-OSCAR-14 OBC and dumped by the command station. These surveys show that the satellite is tumbling in a complex manner, as would be expected after separation from the launcher. Other channels surveyed include the transmitter output power, the solar-panel currents, various temperatures, and the battery voltage. All of these critical telemetry points indicate that the satellite is healthy.

The next step in the commissioning of UoSAT-OSCAR-14 is to deploy the navigation magnetometer. This instrument measures the strength and direction of the Earth's magnetic field at the satellite, and the magnetic field data is used to determine the pointing or "attitude" of the satellite. The magnetometer will rise above the top of the satellite on a 30cm arm, to reduce the effects of magnetic fields generated by devices onboard the satellite. A spring-loaded hinge will raise this arm, which is now lying flat on top of the satellite. The arm is currently secured by a mechanical interlock with the main gravity-gradient boom. By ground command, we will fire two pyro-electric bolt cutters, releasing the main gravity-gradient stabilization boom. The boom will then be moved out a few centimeters, releasing the magnetometer arm. Correct deployment will be confirmed by taking a WOD survey of the magnetometer channels during the deployment sequence.

Once the magnetometer is deployed, the FORTH DIARY will initiate attitude control software to stop the satellite from tumbling. After this has been accomplished, the main gravity gradient boom will be extended and software to attain Earth-pointing lock will be executed. These maneuvers should be undertaken during the next 10-14 days, if all goes well. — *Jeff, GØ/K8KA*

January 24, 1990 UoSAT-OSCAR-15

UoSAT-OSCAR-15 was also loaded with the FORTH DIARY on the 2025 UTC pass on 22 January. The DIARY executed as expected, telemetry values were nominal, and a WOD survey was started during the 2206 UTC pass. At this time the Z-80 secondary OBC was also running, providing 10 minutes of beacon ON time followed by 10 minutes of beacon OFF time. Telemetry from the DIARY was automatically recorded at the UoSAT Control Station during the 2330 UTC pass, and no unexpected values were observed. The satellite was tumbling (as expected) and internal temperatures were near 20 degrees C — a comfortable room temperature.

During the 1010 pass on 23 January (approximately 25 hours after the satellite was initially commanded to life) no downlink was received at Surrey from UoSAT-OSCAR-15. On subsequent passes we have attempted to refine our tracking data and determine whether or not the satellite is transmitting on the expected downlink frequency (435.120 MHz).

Any accurate reports of UoSAT-OSCAR-15 reception after 2330 UTC on 22 January are solicited. The nominal downlink frequency is 435.120 MHz, and transmissions are at 1200 bits/second AFSK-FM. — *Jeff, GØ/K8KA.*

January 24, 1990 Radio observations, Revs. 36 & 37

Radio observations of DOVE during Revs. 36 and 37 show that the N4HY/W2RS element set, as distributed via ANS, still gives the best fit (within a few seconds). The RGO element set which Max identifies as Object D with an epoch time of 23.61178565 came within half a minute (DOVE was about 30 seconds early relative to that set) while the RGO element set identified as Object H was way off. What I do not understand about the Object D element set is why the drag factor should be so large. It is of the same order of magnitude as MIR, despite the facts that MIR is much larger and at a lower altitude than MicroSat. Also, we may soon be getting to the point where objects drifting apart will introduce significant variables. Since I can only concentrate on one object at a time, we need more people (radio observers) concentrating on different objects. Radar observations cannot tell one object from another at this stage since they are not carrying radar transponders. We need radio observations to correlate with the radar-derived element sets in order to figure out which object is which; this need is likely to continue for several weeks. — *Ray, W2RS*

January 24, 1990 SAT Catalog

The AMSAT Office received a call from Jim Brooks, who works at Goddard as NORAD's liaison person. He said that NORAD needed *our* Keplerians before they'd go out hunting for the bird????????? and that with this information, NORAD should have Keplerians for all the satellites by Thursday afternoon. Without these elements to "get them in the ballpark", he said it would take "a long time" for

NORAD to find our satellites! He also gave me the catalog identifiers for all the birds:

90 05A = Spot
90 05B = UoSAT-D
90 05C = UoSAT-E
90 05D = MicroSat 1
90 05E = MicroSat 2
90 05F = MicroSat 3
90 05G = MicroSat 4
90 05H = 3rd Stage Rocket Body

— *Eric, WA6YBT*

January 24, 1990 UFO?

Who/what else is on 145.825 MHz? I copied a single unproto packet from "NOCALL>CQ <C>" on 145.825 MHz right after a DOVE pass over the Washington DC area this evening. Was that a ground station or something further away? Later, on the next pass, a well known BBS call was also seen. I telephoned the SYSOP, apparently he had turned the BBS on again after the pass and forgotten to QSY back to his normal frequency. — *Joe, W3/G3ZCZ*

January 25, 1990
WDØHHU Returns Home, Finally!

Greetings to all from Littleton, CO. I got in a couple of hours ago from beautiful Fr. Guiana! It was 27 deg F here and the wind was blowing. When I left Cayenne this morning, it was raining — as usual — but very, very hot. I have been on planes all day today. I saw KO5I in my stop over in Dallas and he gave me a very beautiful watch which had engraved on the back "AMSAT MICROSAT LAUNCH CAMPAIGN: DEC '89 - JAN '90." *Thanks Guys!!* This was one hellava hard launch campaign but it certainly did have a GREAT ending!! 73's to all who supported and helped and did all the hard things and put in the heroic efforts! — *Dave, WDØHHU (AMSAT LAUNCH OPERATIONS MANGER — Now Retired — For Awhile)*

January 24, 1990 LUSAT Status

I have commanded LUSAT back on. It is in much better shape now. It does NOT have a negative power budget. It is the underdamped power control loops running the power up in light and down in darkness too quickly. A fix is on its way in the first software load.

The software folks are about ready to start loading new software. Harold will probably report on that here after he begins. WEBERSAT is the first intended recipient and DOVE (because it is a little more complex) will be last. All the spacecraft are easily commandable and we should begin testing receiver sensitivity in the next couple of days. The spacecraft are nice and cool and Dick Jansson, WD4FAB, got the thermal model right on the head. Only WEBER's -Z axis seems out of place, running cooler than others. Cool is good on these birds. The solar arrays generate more power and the batteries have more capacity. — *Bob, N4HY*

January 24, 1990 Figuring Them Out

Further to Bob's and my earlier notes, here is how you can help us tell which satellite is which over the next several weeks:

First, keep abreast of all the latest element sets as they are posted. Remember that the object identifications will be tentative at best and probably wrong. Log each element set into your tracking software with a distinctive identifier which will enable you to identify predictions according to which set produced them, not which object the author of the set thought he was tracking.

Second, select an object on which to concentrate for that pass. It is unlikely that you will be able to produce good tracking data on more than one object at the same time.

Third, run yourself a set of predictions for the object you will be tracking. If you have more than one set available, run a set from each. I find that 30-second readouts (0.5 minutes) work best if your software will produce them, otherwise 1-minute.

Fourth, collect your tracking data. You will need to determine exact times of AOS, LOS and time of closest approach (TCA). A receiver with BFO on in the SSB or CW position works much better for this purpose than an FM receiver. TCA is best derived from a Doppler curve (see the *Satellite Experimenters Handbook* if you don't already know how to take one).

Fifth, compare your observed results with those predicted by the various sets you have. Determine which set correlates best with your observations and how far off it is (e.g., the satellite was 30 seconds early). — *Ray, W2RS*

January 24, 1990 MicroSat Software Status

WB6YMH and I spent most of today testing the new software load that was scheduled for tonight, but we encountered an odd problem. We used a leftover CPU board for testing, one that was rejected for flight. For good cause, as it turns out, as its B receive channel generated many overrun errors, for no good reason as far as we can tell. It took several hours to track this down as the cause of the test failure. On the other hand, we now have a fix should

we ever encounter this on orbit.

The first upload of post-launch software is now scheduled for tomorrow. — *Harold, NK6K*

January 24, 1990
Terrestrial Operations on 145.825 MHz

In the Los Angeles area, I've already been monitoring activity like:

N6XXX>WASH,DOVE-1: <C>

and

N6YYY>BEACON,AA6TN-9: CQ CQ CQ, PLEASE CONNECT AND LEAVE A MESSAGE

on 145.825 MHz immediately following DOVE passes and at other random times. (AA6TN-9 is on another frequency, this operator just didn't change his UNPROTO when moving over.) (Callsigns have been changed to protect the guilty.) I don't know how much activity like this was going on (if any) before DOVE showed up on frequency, I wasn't monitoring 145.825 MHz for packets before this week.

Presumably, these operator's DCDs are holding them off the air during actual passes so we're not seeing actual QRM, we're just seeing terrestrial activity after LOS. — *Courtney, N5BF*

January 25, 1990 UoSAT-OSCAR-14

UoSAT-OSCAR-14 operations continue to go smoothly. During evening passes over the UK on 24 January, we executed a preliminary test of the Z-axis magnetorquer. This is a critical operation because the torquer operating at maximum power draws 1 amp from the 14-volt power supply. This triples the demand on the power system. To perform this operation safely, the 1802 OBC was programmed to turn on the torquer and then to turn it off after one minute. During the torquing, a whole-orbit data (WOD) survey of magnetometer and power system channels was collected. The magnetometer readings indeed showed the field generated by the torquer, and allowed us to confirm the polarity of the generated field. No ill effects on the power system were observed.

In the morning, we executed the planned deployment of the navigation magnetometer 'arm'. This involves firing pyrotechnic bolt cutters and then extending the main gravity gradient boom a few centimeters. Again, the operations were done under strict OBC sequence control to minimize the possibility of errors (or the effects of ground command failure). Because pyro firing is too fast to observe on the 14-volt current telemetry point, special confirmation wires were inserted into the path of the bolt cutter. When the cutter is activated, the wire is broken, and this is monitored by a digital status point. The pyros fired successfully — again confirming the high-current capacity of the power system. After the bolts were cut, the boom motor was turned on for five seconds; this was confirmed both by the 14-volt current monitor and by the ''boom extension meter'', which indicated a very small extension of the boom. Simultaneously, the magnetometer arm sprung into position, causing easily observable changes in the magnetometer readings.

These three critical operations on UoSAT-OSCAR 14 (magnetorquer test, pyro firing, and magnetometer deployment) clear the way for new OBC software to acquire ''magnetic lock'', in which the satellite is locked to the Earth's magnetic field in preparation for complete extension of the gravity gradient boom.

We are currently downlinking telemetry and WOD in binary formats from the OBC. The standard ASCII format for WOD will be initiated as soon as possible — perhaps tonight or tomorrow morning (UTC). ASCII telemetry, on the other hand, is not available from the new satellites. If there is demand, we can distribute the binary format information, but these formats will only be in use on UoSAT-OSCAR 14 until the PACSAT Communications Experiment (PCE) is commissioned, so extensive software development by listeners is not likely to be worthwhile.

Oh, we powered up the PCE 80C186 today and checked that its bootloader was functioning. No problems were experienced. — *Jeff GØ/K8KA*

January 25, 1990 UoSAT-OSCAR 15

We still have heard nothing from UoSAT-OSCAR 15 since 22 January. Keplerian elements from Royal Greenwich Observatory show that the MicroSats and UoSATs are in a small group, but one object is some five minutes ahead of the others. We are attempting to determine more from other radar sites.

Any accurate reports of UoSAT-OSCAR 15 reception after 2330 UTC on 22 January are solicited. The nominal downlink frequency is 435.120 MHz, and transmissions are at 1200 bits/second AFSK-FM. — *Jeff GØ/K8KA*

January 26, 1990 MicroSat Elements

Here's a set of elements for what are being called 1990 005A and 1990 005H, since they were not included in Max White's list. These came from the Celestial BBS.

```
1990 005A
1 20436U 90   5   A 90 23.82409993  .00004306  00000-0  17953-2 0     77
2 20436   98.7217 100.2931 0003389 178.5625 181.5624 14.26691687    258
1990 005H
1 20443U 90   5   H 90 23.82219061 -.00030107  00000-0 -12187-1 0     73
2 20443   98.7165 100.2885 0010048 210.8523 149.2068 14.28223237    250
```

I wouldn't make ANY assumptions about which of the 8 element sets correspond to which real objects, including SPOT and the launcher. At the moment 005B is well ahead of the pack and 005A is well behind, with the others bunched in the middle. C and E look almost identical. I'm not sure what all this tells us, since I don't know what maneuvers (if any) were done by SPOT and the launcher after separation, nor do I know the precise velocity vector of each separation.

If we could get radar cross section data we could narrow things down, but lacking this we'll have to wait for all the objects to spread out. Then we can tell NORAD which is which. — *Phil KA9Q*

January 26, 1990
First Microsat Program Load

The first post-launch software was uploaded to WEBERSAT this evening. The upload was started on the east coast by N4HY and completed by NK6K/W6TRW on the west coast. We'll use this technique of uploading large programs over several passes by multiple command stations to counter the relatively short access times.

During the first pass over Los Angeles (LA), the satellite was getting perfect copy of 152-byte packets while it was still near the horizon, with 25 Watts into a KLM-22C. We didn't try to see how low with RF we could go, as we wanted to get the software in. It appears that the satellites will be as easy to get into as we hoped. Receiver sensitivity and channel centers will be calibrated in the days to come.

An improved loader in now running on WEBERSAT, although the new battery control algorithm is not yet loaded.

The WEBER transmitter was off from Friday Jan 26 05:06:30 1990 UTC until Thursday Jan 26 06:37:06 1990 UTC. The UTC date on WEBER was set to 1989 by mistake, this will be corrected in the morning.

We are still in the process of installing factory field upgrades to WEBERSAT in preparation of turning it over to the ''customer'' sometime next week. — *Harold NK6K*

January 27, 1990 WEBERSAT
Impact Sensor Reset

As an addendum to NK6K's note of 0845 GMT Friday, please be aware that immediately after WEBERSAT's resumption of transmission at 0637 UTC on January 26, 1990, the ''customer'' cycled the sensor package power. Anyone monitoring the impact sensor should log this because the sensor reading resets when power up occurs. The current default for the package

is ON.

Talking about an impact "Today, the state of Utah's Board of Regents voted against the heated objections of the University of Utah and Utah State University to change the status of Weber State College. The matter had been under consideration for some time. Upon approval of the state legislature [with only 15 votes required for passage, the bill has 30 sponsors] the school will henceforth be called Weber State University. The successful launch of Webersat was called "significant" as an influence on the decision. — *Chris WA3PSD*

January 27, 1990
More WEBER Information

In some still mysterious interaction between TZSET, the upload program, and N4HY, WEBER was changed from the correct time but wrong date to the correct date but the wrong time. It was finally corrected on the 2nd west coast pass at Friday January 26 18:54:51 1990 UTC.

We're currently 1/2 way through the upload of the Rev. 3 loader, which contains the Rev. 2 power management routines. The BCRXMT messages will go away in this version.

Once this is in (should be in by January 27 19:00 -20:00 UTC), we'll start loading the rest of the system support software. That is the last step before WSC (soon to be WSU) takes over and starts uploading their application software.

The delay has been in investigating a minor problem that has affected WEBER, DOVE, and LUSAT, but not PACSAT. Occasionally (every few days?), a large packet will be sent, probably 65k. WB6YMH and I have added several diagnostic variables to help locate the problem. An "over" message has been added to the telemetry which will count up if it happens again. More than one count will be reported for each occurrence.

If you hear a long packet, please note the time and satellite, and let us know. This can be determined by ear, as the standard telemetry and flags is a distinctive rhythm, but the long packet has no intervening wait time and will continue for several minutes. — *Harold NK6K*

January 27, 1990 Observations

Observations taken during Rev. 80 using the two-line element sets identified as 90 05A-H are as follows: Object B, which leads the group, does not appear to be a radio object (or if it is, it's turned off). The same can be said for Object A, which lags the group. Object H, which lags the group only slightly, appears to be UoSAT-OSCAR 14, transmitting on approximately 435.07 MHz. The other objects, identified as C through G, are too close together to make definitive conclusions at this time. Anyone care to agree or disagree, based on their own observations?— *Ray W2RS*

January 27, 1990
Ray's observations

I not only agree with Ray's conclusions but think they MIGHT actually have the objects identified correctly (in the order they came off plus the spring constants). Jan made remarks to me that this might be the case and I looked carefully at these and it appears they are GOOD ELEMENTS even though some have negative drag. For the time being, it would be best to update often WHILE KEEPING THE OLD STUFF around just in case. — *Bob, N4HY*

January 28, 1990
MicroSat Transmitter Frequencies

Phil, KA9Q is interested in conducting Doppler measurements for all of the SPOT mission spacecraft in the interest of sorting out the separating bodies as soon as possible and in deriving the orbital elements for same. In so doing, he asked me for the precise frequencies of the transmitters. It

occurred that others may also be interested in making these measurements and that these exact frequencies have not yet been distributed.

The frequencies listed were taken after the completion and final tuning of the completed transmitter assemblies. The temperatures were taken at 23 deg. C. Note that currently, the transmitter temperatures are closer to 0 deg. C.

Exact (?) MicroSat Transmitter Frequencies (MHz)

Transmitter	PACSAT	WEBERSAT	LUSAT	DOVE
FM No. 1	N/A	N/A	N/A	145.82516
FM No. 2	N/A	N/A	N/A	145.82438
Normal PSK	437.02625	437.07510	437.15355	N/A
Raised Cosine	437.05130	437.10200	437.12580	N/A
S-Band	2401.1428	N/A	N/A	2401.2205

Here's what enchanted me about the element sets forwarded by the Royal Greenwich Observatory. I assume that the RGO measurements were unbiased in that they were based strictly on observations and were not adjusted in any way to account for a prior knowledge of the separation spring velocities predicted for the satellites.

Now, note that during the launch sequence, the vehicle third stage did a reorientation maneuver just prior to our separation. This separation was approximately against the velocity vector of the orbit (KA9Q to confirm this). Bang. All four spacecraft were separated within 300 mS of one another. In this case, the spacecraft with the highest spring velocity should be in the orbit with the shortest period and therefore, the largest mean motion. The spring velocity applied, as it was, near perigee and with a negative sign, would have a tendency to lower the apogee of each orbit. This reduces the semimajor axis and increases the mean motion parameter. Note the following table:

S/C	Est. Sep. Vel.	RGO Mean Motion
AO-16	0.95 m/s	14.28443513
DO-17	1.10 m/s	14.2856939
WO-18	1.26 m/s	14.2870565
LO-19	1.39 m/s	14.28762058

The spring velocity was calculated just before mating to the vehicle once the final masses of the satellites were known. The mean motion data is from the element sets received here. Isn't science wonderful! Assuming no monkey business, it looks to me like we have a good case for identifying the four MicroSat objects.

I don't know if anyone has run out these elements into the future but, it's quite interesting. I wouldn't take this data to be absolute by any means but, it gives us a good relative idea of what will happen to the orbits in the future. I noted three thing of interest:

1) PACSAT and DOVE will be separated by about the distance of the diameter of their visibility circles by mid-April.

2) LUSAT, the fastest S/C will lap PACSAT, the slowest S/C by early December. Thus, the satellites will get closer together again after about a year.

3) If the mean motion numbers above are close to being correct, WEBERSAT probably was separated slightly faster than we anticipated. This either means that it tumbled less than the others (possible) or the separation spring measurements made by the vendor were on the low side of reality. A lower tumble rate would result if less of the spring's energy was converted to rotation instead of translation. As a consequence, WEBERSAT and LUSAT do not separate from one another very fast at all. It takes more than half a year before they are separated by the diameter of a visibility circle.

To see how all this unfolds, we need more data. Interesting "stuff." — *Jan W3GEY*

January 28, 1990 Myriad Details

Several changes have been made. WEBER is running the new power/charging control algorithm. It appears to be unconditionally stable. LUSAT is next. The Argentineans are wondering what we are talking about with this power instability business. They always see all the transmitters set up at high power no matter what. Can you guess why? (Hint: consider the time of year). The batteries on WEBER should slowly get into much better shape, though they appear to be in good shape now. With this up and down yo-yo on the power we were probably going to build some memory into the NICADS on board, we just weren't building up any long term net positive charge, and the batteries were charging at nearly maximum allowable rate while they were in the sun. This was caused primarily by linear thinking on the power setting algorithm. It has a different slope on the top and the bottom of the power setting curve.

PACSAT has been switched back to the straight PSK transmitter for several reasons including that it appears to be a great deal more efficient. We are investigating.

WEBER has not sent one of these really long packets Harold was talking about as of the last pass over the U.S. last night, possibly the bug was found prior to yesterday's load.

The PACSAT S band beacon has been on but one orbit. It is quite loud if you have a moderate setup and was over S-9 on a 30 degree pass into a five foot dish here. The DOVE S band beacon will not come on until the operational code that implements the first speech/telemetry alternation is installed. After PACSAT has its new code uploaded in the next couple of days, we will begin to use the S band beacon at least once per week.

I swapped WEBER back to straight PSK. I would appreciate comments, especially from Ogden. I have had numerous complaints that it sounds ratty on Raised Cosine. There is a phase adjustment that I must make (yes we can change the phasing from the ground) and then the RC PSK should sound better. For now, we need to get the telemetry.

DOVE has had its IR sensor switched to the logarithmic scale. — *Bob N4HY*

January 28, 1990 More on RGO Element Set

To continue with the relationship between the springs and the mean motion posted last night, I took the data to its logical conclusion. Consider the following table:

S/C:	RGO Mean Mot.:	Calc. SMA (a):	Circ. Orb. Vel:
AO-16	14.28443513 /day	7161.801 km	7460.321 m/s
DO-17	14.2856939 /day	7161.380 km	7460.540 m/s
WO-18	14.2870565 /day	7160.925 km	7460.777 m/s
LO-19	14.28762058 /day	7160.737 km	7460.876 m/s

The third column is the semimajor axis (SMA) calculated from the RGO supplied mean motion. The fourth column is the velocity as though the orbit was truly circular. This is cheating a bit but, it will give the average velocity for the orbit. From this data I cannot reconstruct the separation velocities due to the springs as determined from the elements but we can come close.

Another table:

S/C	Expected Sep. Velocity:
AO-16	0.95 m/s
DO-17	1.10 m/s
WO-18	1.26 m/s
LO-19	1.39 m/s

We can now compare the differences in spring velocities between any two satellites resulting from the expected separation conditions and the velocities of the satellite orbits calculated from the RGO data:

	Expected Vel. Dif.:	RGO Vel. Dif.:
DO-17 - AO-16:	0.15 m/s	0.22 m/s
WO-18 - DO-17:	0.16 m/s	0.24 m/s
LO-19 - WO-18:	0.13 m/s	0.10 m/s
LO-19 - AO-16:	0.44 m/s	0.55 m/s

Now, I'd say that is good agreement. Not likely a coincidence. What is always amazing to me is how accurate things in this industry have gotten to be. In these calculations we are dealing with the measurement of speeds on the order of 0.1 m/s measured on top of speeds of 7500 m/s! Maybe I'm old fashioned but, it still gets my attention.

In conclusion, I believe that the objects RGO labeled 1990 05D through 1990 05G are indeed correctly identified as AO-16 through LO-19, respectively. I also think that Ariane's reorientation and our separation springs did exactly what they were

supposed to do. — *Jan W3GEY*

January 28, 1990 Some Tentative IDs

Here are some tentative conclusions about the identities of the various objects based on Doppler observations of the 16:20 UTC pass today at KA9Q, N4HY and W2RS.

First of all, according to the element sets, the satellites are coming over in the following order: B-G-F-E-C-D-H-A.

Bob, Ray and I each picked one of the 70cm satellites to monitor during this morning's pass. I took WEBERSAT, Bob took LUSAT and Ray took PACSAT. Measuring TCA was a bit tricky, given the wide PSK modulation bandwidths and the usual carrier-vs-passband center offset confusion. For this pass, which had a maximum elevation of around 55 deg., the accuracy of each measurement was probably 5 seconds or so. (Overhead passes, because of their sharper Doppler curves, are more precise.)

With very high confidence I can say that object F is WEBERSAT , as the match was quite good (4 Sec. difference in my observed vs predicted times vs 35 Sec. for the next nearest object).

With almost as high confidence I can say that C is PACSAT, again with a 4 Sec. difference between W2RS's observation and the predicted time. The only reason I lower the confidence somewhat on this one is because object E was not far ahead of C, with a 14 second difference to Ray's observation.

Bob's observation of LUSAT TCA was 11 seconds after the predicted time for object G. Since object F reached predicted TCA 37 seconds after Bob's observed TCA, I can conclude that object G is probably LUSAT. (Besides, I had already identified F as WEBERSAT!)

This leaves objects E, D and H to be matched with DOVE and the two UoSATs. Ray reports that object H, which trails D by 2 minutes, 20 seconds, is definitely not transmitting anywhere. So it's probably UoSAT- OSCAR 15, since we know it's off the air. This leaves D and E to match DOVE and UoSAT-OSCAR 14. Based on the estimated separation velocities, the four MicroSats should appear in the order LUSAT-WEBER-DOVE-PACSAT. LUSAT, WEBER and PACSAT are observed to match this order, and if DOVE follows the pattern it should be E.

Then by process of elimination, D is UoSAT-OSCAR-14. The distribution of separation velocities was supposed to be more even than the close spacing between E and C would ndicate, but it's possible that the actual velocities were different. The UoSATs were deployed in a different direction, not so much against the velocity vector of the launcher, and with less separation velocity. Therefore, it makes sense that they should trail the four MicroSats. The remaining puzzle is why the two UoSATs, if they are indeed objects D and H, are so far apart.

To summarize the identifications:

Object	Identity	Confidence
A	SPOT	high

(Least eccentric orbit and highest altitude. Well behind all MicroSats and UoSATs. Probably did orbit trim after separation.)

Object	Identity	Confidence
B	launcher	high

(Noticeably higher mean motion than all other objects, probably due to propellant venting against velocity vector after all separations)

Object	Identity	Confidence
C	PACSAT	high

(Doppler observation at W2RS)

Object	Identity	Confidence
D	UoSAT-14	moderate

(Process of elimination in Doppler measurements)

Object	Identity	Confidence
E	DOVE	moderate

(Process of elimination in Doppler measurements; estimated sep velocities)

Object	Identity	Confidence
F	WEBERSAT	very high

(Doppler observation at KA9Q)

Object	Identity	Confidence
G	LUSAT	very high

(Doppler observation at N4HY)

Object	Identity	Confidence
H	UoSAT-15	high

(Process of elimination — not a transmitting object) — *Phil, KA9Q*

January 28, 1990 UoSAT-OSCAR-14

The FORTH Diary software is in operation on UoSAT-OSCAR-14, as programmers MS Hodgart and MLJ Meerman (G0/PA3BHF) ground-test new attitude-determination and control software prior to re-loading the OBC. The standard UoSAT ASCII whole-orbit data (WOD) format has been added to the DIARY's downlink schedule, and new WOD surveys have been conducted daily. Stations with UoSAT-2 decoders and WOD collection software should be able to decode these surveys without difficulty. The surveys which have been transmitted in ASCII so far are a survey of the magnetometer channels (22, 23 and 24 starting at 21:54 on 26 January), and a survey of the PACSAT Communications Experiment 80C186 CPU temperature and current consumption (channels 5 and 44, starting 11:45 on 27 January). The very beginning of the PCE survey clearly shows the 10-degree increase in CPU temperature which occurs when the 80C186 is turned on.

January 28, 1990 UoSAT-OSCAR 15

We still have heard nothing from UoSAT-OSCAR-15 since 22 January. Tracking stations and Amateur listeners have determined that the object "out ahead" of the MicroSat cluster is not UoSAT-OSCAR-15, but the spent Ariane third stage. The object trailing the pack is SPOT-2, which has been raised to a slightly higher orbit and so has lower mean motion than the other satellites.

Accurate reports of UoSAT-OSCAR-15 reception after 2330 UTC on 22 January are desperately needed. The nominal downlink frequency is 435.120 MHz, and transmissions are at 1200 bits/second AFSK-FM. — *Jeff, GØ/K8KA*

January 29, 1990 LUSAT

LUSAT was loaded with the improved loader and improved battery management routines just after uptime is 045/14:31:40. Time is Mon., Jan 29 05:23:33 1990

The average battery voltage should now be higher. — *Harold, NK6K*

January 30, 1990 UoSAT-OSCAR-14

On 29 January, in aid of efforts by KA9Q, W2RS, and others to identify conclusively the orbits of OSCARs 14 through 19, we monitored "sunrise" at UoSAT-OSCAR-14. The sunrise time was 18:57:41 UTC, measured using the onboard hardware telemetry system; this time may be a bit later than the actual sunrise, as the telemetry system takes 3 seconds to sample all channels. We monitored the solar array voltage, which is the first telemetry point to respond to sunlight. The measured time corresponds closely with the "object D" in the current Keplerian element sets.

On 26 January, the OBC collected a WOD survey of the magnetometer channels. Before describing this survey, we must review the satellite axis system: the Z axis is the long axis of the satellite, which will eventually point toward the Earth; the X and Y axes are the axes through the satellite's solar panels.

Qualitatively, the WOD survey shows that the Z axis and the Y axis are measuring the same magnetic fields. The Y axis shows a decidedly different pattern, with two magnetic maxima per orbit. After some analysis, this is interpreted as follows:

1) UoSAT-OSCAR-14 is not spinning about the Z (long) axis.

2) It is spinning about the Y axis, which is called a 'flat spin'.

3) This flat spin has inertially stabilized the satellite in a plane parallel to the Earth's equatorial plane, i.e. with the Y axis pointing north-south.

To visualize this, take a shoe box and place it on a table. The Y axis passes through the top of the box. Stick a pencil through this. The X axis is through the sides, and the Z axis through the ends. The satellite is spinning around on the pencil,

the Y axis. As the satellite orbits, this axis remains pointing north-south.

This analysis can be confirmed by watching the solar panel currents when UoSAT-OSCAR-14 is in sunlight. As it spins about the Y axis, the sun strikes the +X panel, an end of the satellite, the -X panel, the other end of the satellite. The Y panels get very little illumination. This also keeps the X panels warmer than the Y panels.

This inertial stabilization is not having any ill effects on UoSAT-OSCAR-14, though internal temperatures are somewhat lower than final operating temperatures. The next step in acquisition of gravity-gradient lock is to break the flat spin, and line the satellite up with the Earth's magnetic field. This requires active magnetorquing under control of the 1802 OBC. — *Jeff, G8/K8KA*

January 30, 1990 UoSAT-OSCAR-15

We are attempting to determine what has kept UoSAT-OSCAR-15 silent for the past week. Most subsystems on the satellite have redundant backups, and so this silence is puzzling. Many simple failure scenarios (e.g. that there is an uplink problem similar to that experienced on UoSAT-OSCAR-11), are not likely, since the Z-80 OBC should still be commanding the UoSAT-OSCAR-15 beacon on and off even if we are not getting commands in from the ground. The UoSAT-OSCAR-14/15 command system processes all commands from all sources ''simultaneously'', so a runaway OBC could not be blocking ground commands. We are trying all possible command sequences. — *Jeff, GØ/K8KA*

January 30, 1990 PSK Sounds

Concerning reports of ratty downlink sounds, please be aware that during high elevation passes the PSK modem is called upon to issue frequent commands to the downlink receiver, instructing it to sweep frequency in order to track the downlink shift. These frequent commands cause incremental digital steps in tuning. So, near the peak of such passes, when the Doppler shift is most rapid, those frequent commands can sound ratty.

This effect may or may not explain the many reports of poor transmitter quality. — *Chris, WA3PSD*

January 30, 1990 DOVE and Its Use

I am absolutely overjoyed that everyone is finding DOVE to be such a great thing in advertising the Amateur satellite program. I am pleased with all the enthusiasm being shown about its great signal strength and all the great ideas being generated about its use.

Dr. Torres 'Junior' de Castro, PY2BJO, dreamed up the DOVE experiment. He let myself, Tom, Jan, Brooks, and Pat have pretty much free reign in designing the experiments on board with two caveats in mind. (1) It must transmit on two meters, and (2) it must have a good voice experiment. The first, as we are all increasingly aware of, has been done with extreme brilliance by Jose Machao, LU7JCN, with his beautiful two-meter transmitter. DOVE is the most stable battery/power user of the entire lot. The rest are still being tamed. While not perfect, and with compromises made, number 2 has also been achieved. You will soon hear the ROBOT-like digitalker on board sending a greeting and reciting a few telemetry values while we figure out the best way to send the hundreds of thousands of bytes of information needed to make the digital to analog converter on board say something. It has been just great thus far and its capabilities have yet to be explored. DOVE is licensed in Brazil. It has the callsign PT2PAZ. — *Bob, N4HY*

January 31, 1990 New Object Information

I received a phone call late Tuesday afternoon from Max White at RGO. He informs me that the ''boys under the dome'' have definitely identified the B object as being the Ariane final stage and the H object as a UoSAT. However, the report is that H is UoSAT-OSCAR—14. This is almost certainly incorrect. There is no reason to believe that H is a transmitting object. It therefore follows that H must be UoSAT-OSCAR—15. Observations by KA9Q and W2RS indicate that both B and H are non-transmitting and Max assures me that B is the launcher based on Radar cross sections. — *Ed O'Grady, KC2ZF*

Jan 31, 1990 MicroSat Software Development

Some of you might be wondering what we're doing with the MicroSats, and why you can't connect up yet.

The development cycle for these launches was very short. Most of the time available for software development, beyond getting the basic operating system and I/O drivers running, was in writing support code for ground-based hardware checkout. A fully operational CPU wasn't mated to a fully operational spacecraft until very late in the game. Much of the available software time after that went into qualifying the ROM based bootloader. Given the short time available, the goals were :

1) Check out all of the hardware on the ground.

2) Have the best chance possible of getting good telemetry as soon as possible once the spacecraft reached orbit.

This resulted in a limited-feature, but very reliable set of launch support software. This is the software that was running when the ''transmitter on'' commands were sent.

Once the spacecraft were in orbit, several shortcomings in the high-level software loader and in the battery management routines were seen. Bob and I have been working to fix these, in addition to commissioning ground stations which have never talked to MicroSats before, and spacecraft which have never talked to the ground before, times 4.

Once procedures are worked out, they are documented so that new command stations can be brought on line.

Here is a typical day in the life of Bob and Harold. Each day has been like this since launch. Times approximate.

12:00-16:00 UTC Bob wakes up, reads mail from Harold for previous night's passes. Copies early passes, checks action of software loaded last night. Reconfigures S/C as required. Finishes testing new command and control software for next spacecraft. Sends to Harold.

15:00-18:00 UTC Harold wakes up, reads mail from Bob, gets new command and control software from Bob. Integrates with new loader code, tests on spacecraft CPU simulator.

18:00-20:00 UTC Harold to TRW. Starts upload of new software to spacecraft. This is a bit tricky, which is why a new loader is being sent. TRW ARC crew tapes or copies other spacecraft in realtime. Review of all telemetry for all spacecraft.

22:00 UTC Harold sends .EXE which was partially uploaded to Bob to finish uploading. Sends a list of diagnostic variables to WEBER ground station crew to download on their next orbits, or calls to coordinate use of uplinks for WEBER access to their experiments.

22:00 UTC Bob prepares and tests new command and control software for next spacecraft. Harold works on making ground upload software distribution. WEBER tests final camera code on software simulator at WEBER, in preparation for sending to Harold to run on the hardware simulator.

01:00-04:00 UTC Bob completes upload of new software. Prepares source for next spacecraft for start of new cycle. Answers fan mail. Calls Harold to confirm software uploaded.

04:00-06:00 UTC Harold back to TRW. holds breath, tells spacecraft to terminate

the old program and start the new one. Calls Bob to discuss the day. Gets call from WEBER on the diagnostic values. Bob goes to bed.

06:00-08:00 UTC Harold and TRW ARC crew tapes or copies other spacecraft in realtime. Review of all telemetry for all spacecraft. Harold puts status message on telemail.

12:00 UTC Bob up, start again.

Once the basic hardware is checked out, and the batteries are in good shape, this frantic schedule will change. Once the loader and the command software are done being tweaked, they will be turned over to the production command groups, hopefully by the end of this week.

The next goal is to load the application software. WEBER will be ready to do that is a few days. I have to take a business trip, and more development needs doing, which will delay the uploading of the first user-access software until late February. This will allow time for the final hardware checkout, which will include memory tests on the 8 Mb mass memory, determination of channel center frequencies, required uplink power, and the like. — *Harold, NK6K*

January 31, 1990
Anticipated Spacecraft Lifetime

I've been asked by several people what the expected lifetime of the MicroSats is. There are probably three main limiting factors: orbital decay, battery life, and radiation total dose.

1) Orbit lifetime.

A chart in the *Satellite Experimenter's Handbook* shows a lifetime of 40,000-50,000 days at our altitude, or somewhere around 120 years; so orbital decay is not our main worry. The most recent OSCAR to succumb to orbital decay while still active was AMSAT-OSCAR-9. It was launched into a 500km orbit, and lasted eight years.

2) Battery lifetime.

This has been the limit to lifetime for all Amateur spacecraft except UoSAT-OSCAR-9. The early OSCARs were limited to whatever charge was in the batteries at launch, as they didn't have solar cells. Later, the limit was in the number of charge/discharge cycles that could be performed. The MicroSat/UoSAT orbit gives fourteen charge/discharge cycles each day, although the discharge is not very deep. All the spacecraft have variable transmit power levels, so as the solar cells weaken over time (due to radiation damage), and it takes longer to recharge, we can reduce the transmitter power to proportionately reduce the depth of the discharge. The transmitter out powers on the MicroSats can be varied in 15 steps from tens of milliwatts to around 3-4 Watts.

The batteries in OSCAR spacecraft in low orbit have lasted between five and eight years. UoSAT-OSCAR-9 was still looking good as it recentered after 8 years. The spacecraft that most closely models OSCARs 14 through 19 is UoSAT-OSCAR-11. UoSAT-OSCAR-11, launched in March, 1984, has batteries with the same part number as the current spacecraft. They were procured in much the same manner, and where matched and tested by the same group of VITA volunteers in Canada, led by Larry Kayser. These batteries have shown no signs of weakening after almost six years in orbit.

3) Radiation Damage.

Anything above the protection of the atmosphere is subjected to radiation exposure. This is due to the direct and secondary effects of high energy particles, from the sun and elsewhere. In addition to possible immediate effects, such as flipping a bit from 0 to 1 or 1 to 0, which is correctable, a particle hitting in just the wrong place can cause uncorrectable errors, such as a wrong operation internal to the microprocessor, or worse case a CMOS latchup, resulting in high current draw and overheat/fry. The bit flipping is common, the latter events are very unlikely.

We are more likely to fail due to the cumulative effects of this constant bombardment, something called total dose. Once the total dose reaches a certain point, the gates in the transistors that make up the computer and its memories will no longer switch, and that's it. As far as predictions on when this might occur, it would be easy except for two things, we don't know what the total dose in this orbit is, and we don't know the limits for the parts used. That is one of the many things this mission will tell us. UoSAT-OSCAR-14 and UoSAT-OSCAR-15 both carry a package that will measure the total doses received. That way, providing non-critical parts fail first, we can begin to characterize the radiation susceptibility of the non-radiation hardened parts we use.

It should be noted that the MicroSats are in a much more benign orbit than AMSAT-OSCAR-10. AMSAT-OSCAR-10 did not quite reach the desired orbit, and with its 4000 km perigee, spends more time in the Van Allen radiation belts than was planned. AMSAT-OSCAR-10's memories therefore failed sooner than hoped, but the other electronics, the transponders, batteries, and solar arrays live on. Through no-longer actively attitude controlled, and therefore subject to seasonal variations in its solar power, its transponders are still usable many weeks of the year.

AMSAT-OSCAR-13 is in a better orbit with a lower perigee, and should have a longer life.

A fourth reason for failure, random failures, won't be treated here. See the *Satellite Experimenter's Handbook*[5], for more discussion on the subject of lifetime.

In summary, we have no practical limits to life from orbital decay, the same batteries have worked for 5+ years with no degradation yet apparent on UoSAT-OSCAR-11, and we don't know how long the high density chips that make up most of the MicroSat CPU will last. Based on rough estimates of the dose in this orbit, and what the chips can take, we would not expect any problems in this area for two to three years. Since the mass memory is byte-wide, many types of single-chip failures can be avoided in a manner analogous to locking out bad sectors on a hard disk.

UoSAT-OSCAR-11, which uses somewhat similar technology chips, has survived almost six years with a failure of only one small section of memory, and that was several years ago. — *Harold, NK6K*

Not The End, BUT, The Beginning.

References

[1]"The First Flock of MicroSats", Tom Clark, W3IWI, Jan King, W3GEY, Bob McGwier, N4HY, and the AMSAT team, *The AMSAT Journal*, Volume 12 Number 1, May 1989.

[2]The UoSAT-OSCAR-14 and 15 Spacecraft.

[3]"Ariane Launch Vehicle Malfunctions — Phase 3A Spacecraft Lost!", Tom Clark, W3IWI, Joe Kasser, G3ZCZ, *Orbit Magazine*, Volume 1 Number 2, June/July 1980.

[4]*AMSAT Newsletter*, first satellite operation, 1977, 1978, and 1979 "Letters to the Editor".

[5]*The Satellite Experimenter's Handbook*, Martin R. Davidoff, K2UBC. Published by the ARRL and also available from AMSAT.

AMSAT News

(Continued from page 14)

spacecraft parameters and trends to be analyzed. Clearly, any such research will benefit from the most complete dataset possible, thus, it is very important that everyone with captured data send copies to Reid for inclusion in the master archive. Command and monitoring station operators are very dedicated individuals but they all have careers, families, and other responsibilities and have not been able to take data for every visibility of every satellite since launch. Also, each satellite is only visible a small percentage of the

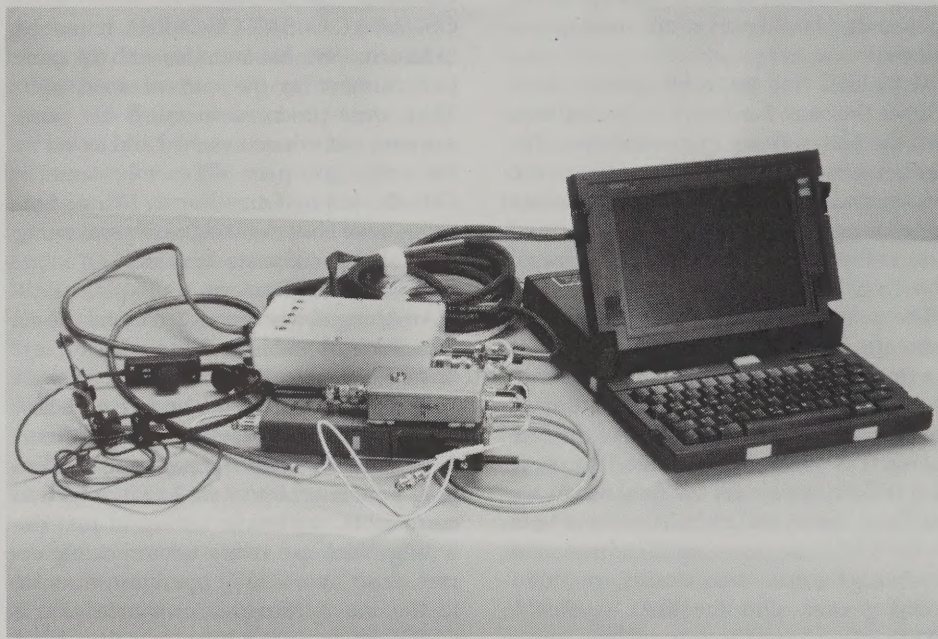
time from any given location. There is no single, complete collection of MicroSat telemetry data; AMSAT is counting on the many Amateur satellite users around the world who have been logging data for the last two months to begin this collection. There is a good chance that the data submitted by any individual is unique and therefore very important to the collection. Submissions are solicited from North and South America, Africa, Europe and Asia, Australia and Oceania, and any other locations for all times since the MicroSat launch.

As the system develops, it will be expanded to include other Amateur satellites besides the MicroSats. Submission standards will be published and Amateurs wishing access to the data for analysis and research will be accommodated.

Reid is prepared to take submissions by mail in any of the IBM-PC 5.25 or 3.5 inch disk formats, Commodore-64 1541, 1571, and 1581 formats, and DEC RX-50 and RX-01/2 formats (as used on the Rainbow 100 and PRO series DEC systems). Those with disks in Apple, Macintosh, or any other formats not listed are asked to write to Reid at the address given below to work out the details of data submission. Files may be compressed using PKARC. Direct, electronic submission of data may be instituted in the future if it is deemed practical.

Data diskettes, inquiries, comments, and other correspondence concerning the Microsat/Amateur Satellite Data Archive may be directed to: Reid Bristor, WA4UPD @ N4JLR, 4535 Deerwood Trail, Melbourne, Florida 32935

Reid also participates regularly in the AMSAT-NA Operations Net on AMSAT-OSCAR-13 and can be contacted there.



Shown in the photograph are some of the various components to be used in the upcoming SAREX operation which, at press time, is scheduled for May 9, 1990. See *The AMSAT Journal*, March, 1990 page 4 for the full story.

ORBITAL ELEMENTS: *The key to decoding this format was published in the March 1990 issue of* The AMSAT Journal.

April 6, 1990

Telephone numbers: DRIG (AMSAT): 214-394-7438
Celestial BBS: 513-427-0674

```
AO-10
1 14129U 83 58  B 90 84.27862046 -.00000064  00000-0  00000 0 0  4622
2 14129  25.9479 212.4769 5985025 129.1636 301.2066  2.05882684 23004

UO-11
1 14781U 84 21  B 90 94.67880985  .00002796  00000-0  52817-3 0  6480
2 14781  97.9579 149.6227 0013721 117.3982 242.8594 14.65131608325206

RS-10/11
1 18129U 87 54  A 90 96.04666951  .00000051  00000-0  49375-4 0   906
2 18129  82.9294  21.8206 0011153 326.5384  33.5024 13.72075535139556

AO-13
1 19216U 88 51  B 90 84.34076849 -.00000112  00000-0  99999-4 0   831
2 19216  57.0247 162.9141 6918075 223.7284  54.0834  2.09703072 13642

UO-14
1 20437U 90  5  B 90 94.70565768  .00000068  00000-0  35155-4 0   455
2 20437  98.7005 171.0195 0011693  13.2313 346.9172 14.28544602 10373

UO-15
1 20438U 90  5  C 90 94.22658296  .00000672  00000-0  28542-3 0   386
2 20438  98.7043 170.5385 0010972  16.8573 343.2924 14.28317844 10301

AO-16
1 20439U 90  5  D 90 91.26911740  .00000991  00000-0  41019-3 0   360
2 20439  98.7136 167.6512 0012244  22.3626 337.8129 14.28645767  9884

DO-17
1 20440U 90  5  E 90 95.74964558  .00000943  00000-0  39093-3 0   304
2 20440  98.7115 172.1224 0012269  10.3414 349.7970 14.28691837 10521

WO-18
1 20441U 90  5  F 90 95.74389687  .00000662  00000-0  27873-3 0   265
2 20441  98.7027 172.1163 0012666  11.3964 348.7487 14.28796561 10520

LO-19
1 20442U 90  5  G 90 96.09052163  .00000863  00000-0  35773-3 0   330
2 20442  98.7059 172.4701 0012995  10.2072 349.9342 14.28866649 10573

FO-20
1 20480U 90 13  C 90 93.62525126  .00000132  00000-0  34767-3 0   208
2 20480  99.0483 154.1880 0540612 217.3591 138.8750 12.83124235  7181

NOAA-9
1 15427U 84123  A 90 96.08678677  .00000747  00000-0  42473-3 0  4996
2 15427  99.1673  94.2494 0014761 208.0191 152.0180 14.12510700273806

NOAA-10
1 16969U 86 73  A 90 95.60129682  .00001002  00000-0  45684-3 0  3607
2 16969  98.6068 125.1540 0014299 118.3689 241.8931 14.23534985184284

MET-2/17
1 18820U 88  5  A 90 92.59416403  .00000273  00000-0  23399-3 0  2110
2 18820  82.5385  50.5428 0016572 172.1421 188.0012 13.84308504109720

MET-3/2
1 19336U 88 64  A 90 96.08854532  .00000392  00000-0  99999-3 0  4006
2 19336  82.5311 328.4357 0016475 127.0081 233.2499 13.16885681 81466

NOAA-11
1 19531U 88 89  A 90 94.37913638  .00000781  00000-0  45082-3 0  2153
2 19531  98.9753  42.6354 0012944 129.3791 230.8527 14.11525101 78551

MET-2/18
1 19851U 89 18  A 90 88.06340460  .00000189  00000-0  16080-3 0  1604
2 19851  82.5205 292.3062 0012806 230.8733 129.1289 13.83951283 54481

MET-3/3
1 20305U 89 86  A 90 92.56234753  .00000014  00000-0  22701-4 0   718
2 20305  82.5491 271.3387 0015898 154.2148 205.9766 13.15853081 21001

SALYUT  7
1 13138U 82 33  A 90 95.98277252  .00033348  00000-0  43824-3 0  1411
2 13138  51.6048 308.3357 0000978 176.7585 183.3380 15.58177308453579

MIR
1 16609U 86 17  A 90 95.97464766  .00034006  00000-0  38964-3 0  5156
2 16609  51.6183 334.3254 0013691 359.0982   0.9952 15.61666435236827
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- Rotor Interface Option (to connect to ANY rotors) .... $ 30
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